TETRA TECH

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USEPA Approved Report

Total Maximum Daily Loads for the Tug Fork River Watershed, West Virginia

Prepared for:
West Virginia Department of Environmental Protection
Division of Water and Waste Management
Watershed Assessment Branch, TMDL Section

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On the cover:
Photos provided by WVDEP Division of Water and Waste Management

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ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

7Q10	7-day, 10-year low flow
AMD	acid mine drainage
AML	abandoned mine land
AML&R	[WVDEP] Office of Abandoned Mine Lands & Reclamation
BMP	best management practice
BOD	biochemical oxygen demand
CFR	Code of Federal Regulations
CSGP	Construction Stormwater General Permit
CSR	Code of State Rules
DEM	Digital Elevation Model
DMR	[WVDEP] Division of Mining and Reclamation
DNR	West Virginia Division of Natural Resources
DO	dissolved oxygen
DWWM	[WVDEP] Division of Water and Waste Management
ERIS	Environmental Resources Information System
GIS	geographic information system
gpd	gallons per day
GPS	global positioning system
HAU	home aeration unit
LA	load allocation
ug/l	micrograms per liter
MDAS	Mining Data Analysis System
mg/L	milligrams per liter
mL	milliliter
MF	membrane filter counts per test
MPN	most probable number
MOS	margin of safety
MRLC	Multi-Resolution Land Characteristics Consortium
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NLCD	National Land Cover Dataset
NOAA-NCDC	National Oceanic and Atmospheric Administration, National Climatic Data Center
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OGCSGP	Oil and Gas Construction Stormwater General Permit
OOG	[WVDEP] Office of Oil and Gas
POTW	publicly owned treatment works
SI	stressor identification
SRF	State Revolving Fund
STATSGO	State Soil Geographic database
TMDL	Total Maximum Daily Load

TSS	total suspended solids
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UNT	unnamed tributary
WLA	wasteload allocation
WVDEP	West Virginia Department of Environmental Protection
WVSCI	West Virginia Stream Condition Index
WVU	West Virginia University

Watershed

A general term used to describe a drainage area within the boundary of a United States Geologic Survey's 8-digit hydrologic unit code. Throughout this report, the Tug Fork River watershed refers to the tributary streams that ultimately drain to the Tug Fork River (**Figure I-1**). The term "watershed" is also used more generally to refer to the land area that contributes precipitation runoff that eventually drains to the mouth of the Tug Fork River.

TMDL Watershed

This term is used to describe the total land area draining to an impaired stream for which a TMDL is being developed. This term also takes into account the land area drained by un-impaired tributaries of the impaired stream and may include impaired tributaries for which additional TMDLs are presented. This report addresses 273 impaired streams contained within 88 TMDL watersheds in the Tug Fork River watershed.

Subwatershed

The subwatershed delineation is the most detailed scale of the delineation that breaks each TMDL watershed into numerous catchments for modeling purposes. The TMDL watershed has been subdivided into 838 modeled subwatersheds. Pollutant sources, allocations and reductions are presented at the subwatershed scale to facilitate future permitting actions and TMDL implementation.

Assessment Units

Assessment units are the smallest reach of a stream for which attainment of water quality standards is assessed and reported by the WVDEP in the USEPA Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS). This report addresses 328 impaired assessment units in the Tug Fork watershed. Assessment unit designations appearing in this TMDL will be utilized in future reports in ATTAINS. Assessment unit identifiers (AUIDs) are created by combining NHD codes with an ordering system following a top-down schema with "01" being in the headwaters and orders increasing downstream.

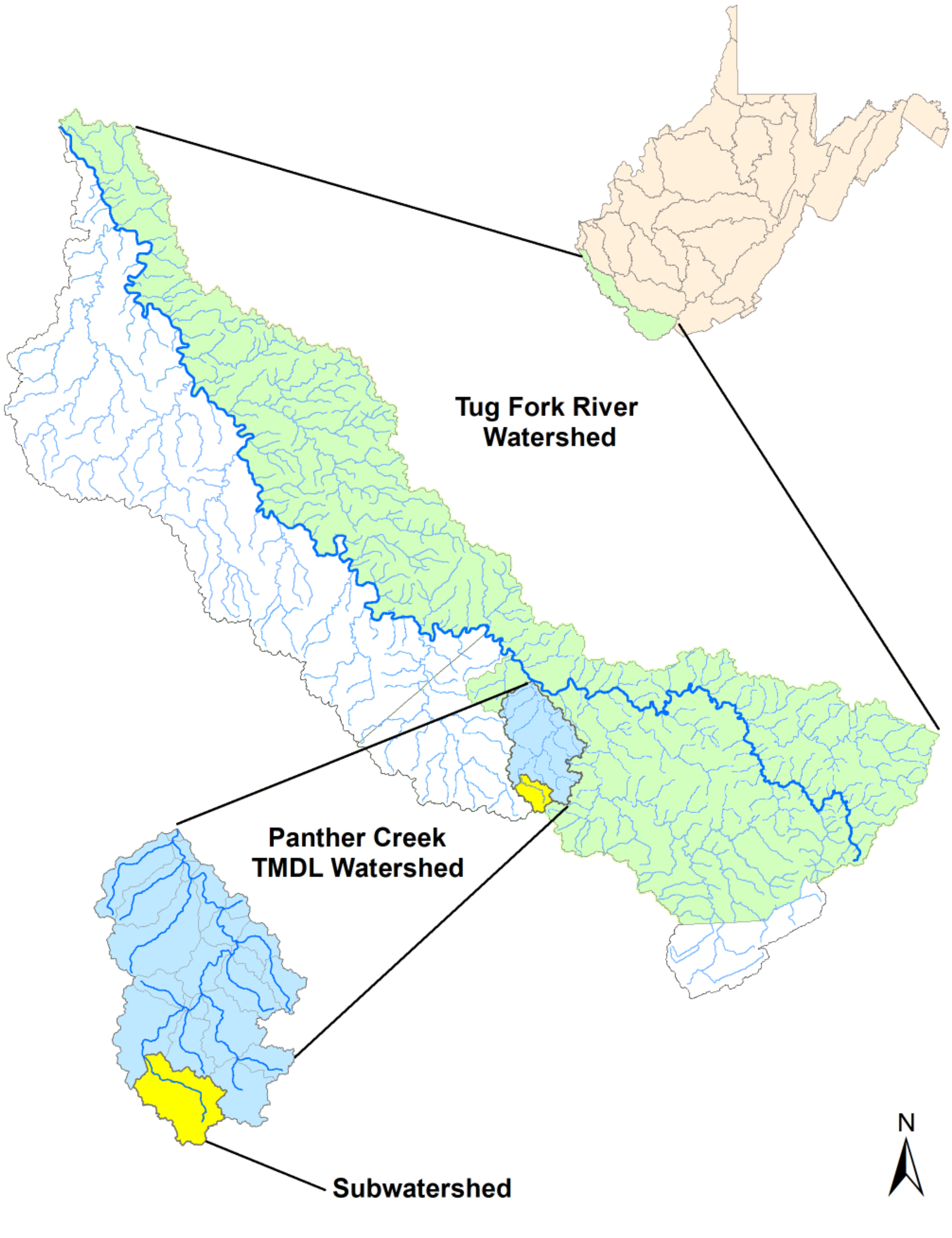


Figure I-1. Examples of a watershed and subwatershed

EXECUTIVE SUMMARY

This report includes Total Maximum Daily Loads (TMDLs) for 328 assessment units in the Tug Fork River watershed. This project was organized into 88 TMDL watersheds, which account for all streams draining to the Tug Fork River. TMDLs are presented for assessment units. Assessment units are the smallest reach of the stream for which attainment of water quality standards is assessed and reported by the WVDEP in the USEPA Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS). Assessment unit designations appearing in this TMDL will be utilized in future reports in ATTAINS. Depending upon the size of the drainage area and predominant land uses, some streams may be broken down into multiple assessment units.

Coordination between USEPA Region 3, USEPA Region 4, West Virginia, Kentucky, and Virginia state TMDL programs occurred prior to iron and fecal coliform TMDL development for the Tug Fork River mainstem. Pre-TMDL water quality monitoring at the mouths of major Kentucky tributaries indicated these streams contribute loads of iron and fecal coliform that should be accounted for in the TMDL project. Incorporation of Kentucky and Virginia portions of the Tug Fork watershed into the TMDL development process is described in **Section 3.2** of this report.

A TMDL establishes the maximum allowable pollutant loading for a waterbody to comply with water quality standards, distributes the load among pollutant sources, and provides a basis for actions needed to restore water quality. West Virginia's water quality standards are codified in Title 47 of the *Code of State Rules* (CSR), Series 2, and titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. The standards include designated uses of West Virginia waters and numeric and narrative criteria to protect those uses. The West Virginia Department of Environmental Protection routinely assesses use support by comparing observed water quality data with criteria and reports impaired waters every two years as required by Section 303(d) of the Clean Water Act ("303(d) list"). The Act requires that TMDLs be developed for listed impaired waters.

Many of the subject impaired streams are included on the West Virginia's draft 2018/2020/2022 Section 303(d) List. Documented impairments are related to numeric water quality criteria for total iron, pH, aluminum, selenium, dissolved oxygen, and fecal coliform bacteria. Selenium water quality standards are not addressed in this TMDL effort. WVDEP is assessing additional data to verify the impairment and determine the appropriate process to establish TMDLs where fish tissue indicates impairment.

The narrative water quality criterion of 47 CSR 2–3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, and biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). WVSCI-based "biological impairments" were included on West Virginia's Section 303(d) lists from 2002 through 2010.

In 2012 legislative action (codified in §22-11-7b) directed the agency to develop and secure legislative approval of new rules to interpret the narrative criterion for biological impairment found in 47 CSR 2-3.2.i.

§22-11-7b indicates, rules promulgated may not establish measurements that would establish standards less protective than requirements that existed during the 2012 regular session. Thus, WVDEP has continued to list biological impairment based on WVSCI for subsequent 303d lists, including the most recent approved list in 2016. In response to the legislation, WVDEP prepared a draft procedural rule (47 CSR 2B) in 2019 establishing the methodology for determining compliance with the biological component of narrative criteria, but that draft was not finalized. Consistent with previous assessments, WVDEP used the WVSCI scores to determine attainment. The *Aquatic Life Use Assessment and Biological Stressor Identification Procedure, August 2021,* provided in in **Appendix K** to the Technical Report, describes the process used to determine non-attainment.

Although "biological impairment" TMDLs are not presented in this project, assessment units for which available benthic information demonstrates non-attainment of the threshold described in the assessment procedure were subjected to a biological stressor identification (SI) process. The results of the SI process are discussed in **Section 4** of this report and displayed in **Appendix K** of the Technical Report. **Section 4** of this report also discusses the relationship of the pollutant-specific TMDLs developed herein to WVSCI-based biological impacts.

Impaired waters were organized into 88 TMDL watersheds. For hydrologic modeling purposes, watersheds of impaired and unimpaired streams in the Tug Fork River watershed were further divided into 838 smaller subwatershed units. The subwatershed delineation provided a basis for georeferencing pertinent source information, monitoring data, and presentation of the TMDLs.

The Mining Data Analysis System (MDAS) was used to represent linkage between pollutant sources and instream responses for fecal coliform bacteria, pH, aluminum and iron. The MDAS is a comprehensive data management and modeling system that is capable of representing loads from nonpoint and point sources in the watershed and simulating instream processes.

In general, point and nonpoint sources contribute to the fecal coliform bacteria impairments in the watershed. Failing on-site septic systems, direct discharges of untreated sewage, and precipitation runoff from agricultural and residential areas are nonpoint sources of fecal coliform bacteria. Point sources of fecal coliform bacteria include the effluents of sewage treatment facilities public and private. The presence of individual source categories and their relative significance varies by subwatershed.

There is one dissolved oxygen (DO) impairment (Little Slate Creek WV-BST-98-Z_03) in one TMDL watershed. Sources contributing to dissolved oxygen impairments in this watershed are the same as those for fecal coliform. Implementation of the fecal coliform TMDL for Little Slate Creek will reduce the organic loads and will resolve the dissolved oxygen impairment in the stream.

Iron impairments are also attributable to both point and nonpoint sources. Nonpoint sources of iron include roads, oil and gas operations, timbering, agriculture, urban/residential land disturbance and streambank erosion. Iron point sources include the permitted discharges from industrial stormwater and construction sites. The presence of individual source categories and their relative significance also varies by subwatershed. Iron is a naturally-occurring element that is present in soils and the iron loading from many of the identified sources is associated with sediment contributions.

The pH and dissolved aluminum impairments in the watershed are attributable to legacy mining (including abandoned mine lands and permitted bond forfeited sites). In certain watersheds with low buffering capacity, acidic precipitation decreases pH below the pH criterion. Decreased pH may in turn increase the portion of aluminum in solution and result in exceedances of the dissolved aluminum criterion. Atmospheric deposition was not found to be a causative source of impairment as effects are mitigated by available watershed buffering capacity. All active mining sources were represented. Prescribed WLAs were not more stringent than existing NPDES permit limits. Abandoned mine land sources (seeps) are a source of dissolved aluminum and acidity resulting in criteria impairments. In most cases the acidic pH impairments coincide with overlapping metals impairments and the TMDLs for pH impairments were developed using an approach where instream metal (iron and aluminum) concentrations were reduced for attainment of iron and aluminum water quality criteria coupled with direct pollutant reductions to offset acid load from acid precipitation and legacy mine sources. Pollutant reductions are measured and expressed in the amount of alkalinity needed to offset the acid load.

The report describes the TMDL development and modeling processes, identifies impaired streams and existing pollutant sources, discusses future growth and TMDL achievability, and documents the public participation associated with the process. The report also contains a detailed discussion of the allocation methodologies applied for various impairments. Various provisions attempt to ensure the attainment of criteria throughout the watershed, achieve equity among categories of sources, and target pollutant reductions from the most problematic sources. Nonpoint source reductions were not specified beyond natural (background) levels. Similarly, point source WLAs were no more stringent than numeric water quality criteria.

In 2002, USEPA, with support from WVDEP, developed TMDLs for pH and metals impaired streams in the Tug Fork River watershed (USEPA, 2002). In total, TMDLs were developed for 64 streams within the Tug Fork watershed. Iron, aluminum, manganese, and pH impairments were addressed. In this project, all impaired streams for which TMDLs were developed in 2002 have been re-evaluated and new TMDLs, consistent with currently effective water quality criteria, are presented for all current identified impairments. Upon approval, all of the TMDLs presented herein shall supersede those developed previously. Re-evaluation also determined that certain impairments for which TMDLs were developed are no longer effective due to West Virginia water quality standard revisions and new water quality monitoring. All previously developed total aluminum and manganese TMDLs are not effective because of water quality criteria revisions.

Considerable resources were used to acquire recent water quality and pollutant source information upon which the TMDLs are based. TMDL modeling is among the most sophisticated methods available and incorporates sound scientific principles. TMDL outputs are presented in various formats to assist user comprehension and facilitate use in implementation, including allocation spreadsheets, an ArcGIS Viewer Project, and Technical Report.

Applicable TMDLs are displayed in **Section 10** of this report. The accompanying spreadsheets provide TMDLs and allocations of loads to categories of point and nonpoint sources that achieve the total TMDL.

Also provided is the ESRI Online StoryMap at the following link that allows for the exploration of spatial relationships among the source assessment data. https://storymaps.arcgis.com/stories/4f0820b824254fb1a5ca172c6092a020

A Technical Report is available that describes the detailed technical approaches used in the process and displays the data upon which the TMDLs are based.

1.0 REPORT FORMAT

The following report describes the overall total maximum daily load (TMDL) development process for select streams in the Tug Fork River watershed, identifies impaired streams, and outlines the source assessment for all pollutants for which TMDLs are presented. Also described are the modeling process, allocation approach, and measures that will be taken to ensure that the TMDLs are met. The applicable TMDLs are displayed in **Section 10** of this report. An ArcGIS Viewer Project supports this report by providing further details on the data and allows the user to explore the spatial relationships among the source assessment data, magnify streams and view other features of interest. In addition to the TMDL report, spreadsheets (in Microsoft Excel format) that display detailed source allocations associated with successful TMDL scenarios are provided. A Technical Report is included that describes the detailed technical approaches used in the process and displays the data upon which the TMDLs are based.

2.0 INTRODUCTION

The West Virginia Department of Environmental Protection (WVDEP), Division of Water and Waste Management (DWWM), is responsible for the protection, restoration, and enhancement of the State's waters. Along with this duty comes the responsibility for TMDL development in West Virginia.

2.1 Total Maximum Daily Loads

Section 303(d) of the federal Clean Water Act and the U.S. Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (at Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to identify waterbodies that do not meet water quality standards and to develop appropriate TMDLs. A TMDL establishes the maximum allowable pollutant loading for a waterbody to achieve compliance with applicable standards. It also distributes the load among pollutant sources and provides a basis for the actions needed to restore water quality.

A TMDL is composed of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the following equation:

$$\text{TMDL} = \text{sum of WLAs} + \text{sum of LAs} + \text{MOS}$$

WVDEP is developing TMDLs in concert with a geographically-based approach to water resource management in West Virginia—the Watershed Management Framework. Adherence to the Framework ensures efficient and systematic TMDL development. Each year, TMDLs are developed in specific geographic areas. The Framework dictates that 2022 TMDLs should be pursued in Hydrologic Group C, which includes the Tug Fork River watershed. **Figure 2-1** depicts the hydrologic groupings of West Virginia's watersheds.

WVDEP is committed to implementing a TMDL process that reflects the requirements of the TMDL regulations, provides for the achievement of water quality standards, and ensures that ample stakeholder participation is achieved in the development and implementation of TMDLs. A 48-month development process enables the agency to carry out an extensive data generating and gathering effort to produce scientifically defensible TMDLs. It also allows ample time for modeling, report finalization, and frequent public participation opportunities.

The TMDL development process begins with pre-TMDL water quality monitoring and source identification and characterization. Informational public meetings are held in the affected watersheds. Data obtained from pre-TMDL efforts are compiled, and the impaired waters are modeled to determine baseline conditions and the gross pollutant reductions needed to achieve water quality standards. The draft TMDL is advertised for public review and comment, and an informational meeting is held during the public comment period. Public comments are addressed, and the draft TMDL is submitted to USEPA for approval.

In 2002 USEPA, with support from WVDEP, developed TMDLs for metals and pH impaired streams in the Tug Fork River watershed (USEPA, 2002). In total, TMDLs were developed for 64 streams within the Tug Fork watershed. Iron, aluminum, manganese, and pH impairments were addressed. These older TMDLs were developed with a less robust stream monitoring and source tracking dataset and a lower resolution modeling approach. Without a stressor identification process, it was assumed that impairments to aquatic life would be resolved through pollutants TMDLs. Streams for which this assumption were made have been re-evaluated in this project through a formal stressor identification process and specific pollutant TMDLs are identified that will address stress (e.g., total iron to resolve sedimentation stress). In this current project, all impaired streams for which TMDLs were developed in 2002 have been re-evaluated. While pursuing TMDL development for other impairments, WVDEP obtained more comprehensive data and developed new TMDLs under a more refined modeling approach. Upon approval, the TMDLs presented herein for iron and fecal coliform shall supersede those developed previously.

Appendix A of the Technical Report lists TMDLs by pollutant and waterbody developed for this effort.

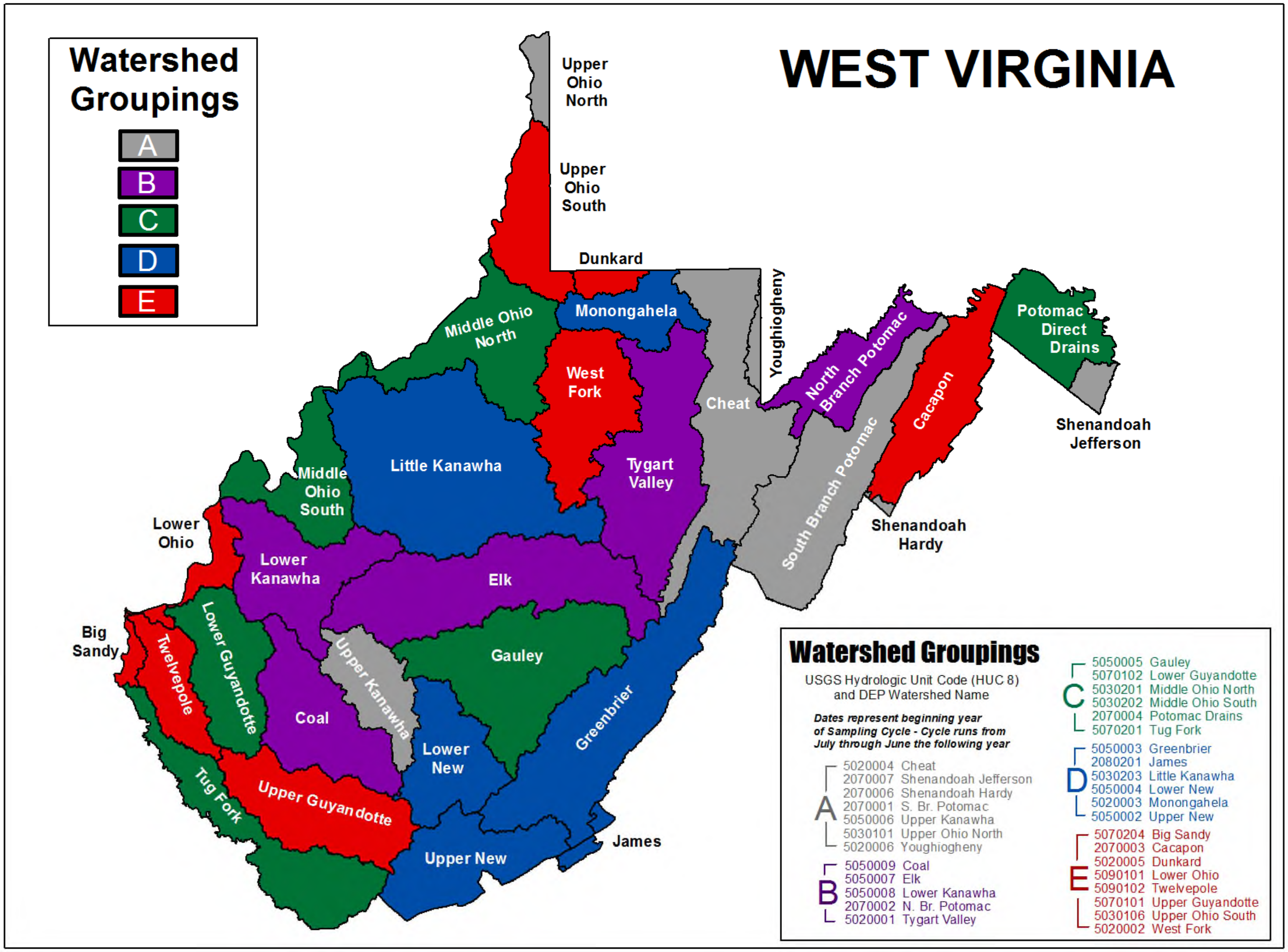


Figure 2-1. Hydrologic groupings of West Virginia's watersheds

2.2 Water Quality Standards

The determination of impaired waters involves comparing instream conditions to applicable water quality standards. West Virginia's water quality standards are codified in Title 47 of the *Code of State Rules* (CSR), Series 2, titled *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards*. These standards can be obtained online from the West Virginia Secretary of State Internet site (http://apps.sos.wv.gov/adlaw/csr/rule.aspx?rule=47-02.)

Water quality standards consist of three components: designated uses; narrative and/or numeric water quality criteria necessary to support those uses; and an antidegradation policy. Appendix E of the Standards contains the numeric water quality criteria for a wide range of parameters, while Section 3 of the Standards contains the narrative water quality criteria.

According to 40 CFR Part 130, TMDLs must be designed to implement applicable water quality standards. The TMDL presented herein is based upon the water quality criteria that are currently effective. If the West Virginia Legislature adopts Water Quality Standard revisions that alter the basis upon which the TMDL is developed, then the TMDL and allocations may be modified as warranted. Any future Water Quality Standard revision and/or TMDL modification must receive USEPA approval prior to implementation.

Designated uses in the Tug Fork River watershed include: propagation and maintenance of aquatic life in warmwater fisheries and troutwaters, water contact recreation, and public water supply. In various streams in the Tug Fork River watershed, warmwater fishery aquatic life use impairments have been determined based on exceedances of dissolved oxygen, dissolved aluminum, total iron, total selenium, and/or pH numeric water quality criteria. Troutwater aquatic life use impairments have been determined pursuant to exceedances of total iron, dissolved aluminum, dissolved oxygen and/or pH numeric water quality criteria. Water contact recreation and/or public water supply use impairments have also been determined in various waters based on exceedances of numeric water quality criteria for fecal coliform bacteria, total manganese, pH, dissolved aluminum, total selenium, and total iron. Selenium water quality standards are not addressed in this TMDL effort. WVDEP is assessing additional data to verify the impairment and determine the appropriate process to establish TMDLs where fish tissue indicates impairment.

All West Virginia waters are subject to the narrative criteria in Section 3 of the Standards. That section, titled "Conditions Not Allowable in State Waters," contains various general provisions related to water quality. The narrative water quality criterion at Title 47 CSR Series 2 – 3.2.i prohibits the presence of wastes in state waters that cause or contribute to significant adverse impacts to the chemical, physical, hydrologic, and biological components of aquatic ecosystems. This provision has historically been the basis for "biological impairment" determinations. Recent legislation has altered procedures used by WVDEP to assess biological integrity and, therefore, biological impairment TMDLs are not being developed. The legislation and related issues are discussed in detail in **Section 4** of this report.

The numeric water quality criteria applicable to the impaired streams in the Tug Fork River Watershed are summarized in **Table 2-1**. The stream-specific impairments related to numeric water quality criteria are displayed in **Table 3-3**.

Table 2-1. Applicable West Virginia water quality criteria

<table>
<tr><th rowspan="4">POLLUTANT</th><th colspan="5">USE DESIGNATION</th></tr>
<tr><th colspan="4">Aquatic Life</th><th>Human Health</th></tr>
<tr><th colspan="2">Warmwater Fisheries</th><th colspan="2">Troutwaters</th><th>Contact Recreation[3]/Public Water Supply[4]</th></tr>
<tr><th>Acute[1]</th><th>Chronic[2]</th><th>Acute[1]</th><th>Chronic[2]</th><th></th></tr>
<tr><td>Aluminum, dissolved (μg/L)</td><td>750</td><td>750</td><td>750</td><td>87</td><td>--</td></tr>
<tr><td>Iron, total (mg/L)</td><td>--</td><td>1.5</td><td>--</td><td>1.0</td><td>1.5</td></tr>
<tr><td>Dissolved oxygen</td><td>Not less than 5 mg/L at any time</td><td>Not less than 5 mg/L at any time</td><td>Not less than 6 mg/L at any time</td><td>Not less than 6 mg/L at any time</td><td>Not less than 5 mg/L at any time</td></tr>
<tr><td>Manganese (mg/l)</td><td></td><td></td><td></td><td></td><td>1.0</td></tr>
<tr><td>pH</td><td colspan="5">No values below 6.0 or above 9.0</td></tr>
<tr><td>Fecal coliform bacteria</td><td colspan="5">Human Health Contact Recreation/Public Water Supply: Maximum allowable level of fecal coliform content for Primary Contact Recreation (either MPN [most probable number] or MF [membrane filter counts/test]) shall not exceed 200/100 mL as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 mL in more than 10 percent of all samples taken during the month.</td></tr>
</table>

[1] One-hour average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[2] Four-day average concentration not to be exceeded more than once every 3 years on the average, unless otherwise noted.
[3] These criteria have been calculated to protect human health from toxic effects through fish consumption, unless otherwise noted. Annual geometric mean concentration not to be exceeded, unless otherwise noted.
[4] These criteria have been calculated to protect human health from toxic and/or organoleptic effects through drinking water and fish consumption, unless otherwise noted. Annual geometric mean concentration not to be exceeded, unless otherwise noted.

3.0 WATERSHED DESCRIPTION AND DATA INVENTORY

3.1 Watershed Description

Located within the Central Appalachian ecoregion, the Tug Fork River is a tributary of the Big Sandy River, which is a tributary of the Ohio River, which joins the Mississippi and flows to the Gulf of Mexico. The Tug Fork River watershed consists of land draining to the Tug Fork River, which begins at its headwaters draining Big Stone Ridge on the Virginia-West Virginia border near the community of Jenkinjones and flows northward to join the Big Sandy River in the City of Louisa, Kentucky. The Tug Fork River is 159.3 miles (256.4 km) long from its headwaters to the Big Sandy River, and its watershed encompasses 1,555.3 square miles (4028.2 km^2). The watershed spans three states, Virginia, Kentucky, and West Virginia, with approximately 932 square miles falling within West Virginia.

The Tug Fork River watershed occupies all of West Virginia's McDowell County, most of Mingo County, as well as the southwestern corner of Wayne County, and a small sliver of Mercer County (**Figure 3-1**). West Virginia cities and towns in the study area are Fort Gay, Kermit, Williamson, Iaeger, and Welch. The highest point in the Tug Fork River watershed is 3,426 feet above sea level on Abbs Valley Ridge above the headwaters of Little Horsepen Creek, a tributary of Dry Fork in Virginia. The lowest point in the watershed is 545 feet at the confluence of the Tug Fork River and the Big Sandy River in the City of Louisa, Kentucky. The average elevation in the watershed is 1,512 feet. Major tributaries of the Tug Fork River in West Virginia include Pigeon Creek, Panther Creek, Dry Fork, Big Creek, and Elkhorn Creek. The total population living in the West Virginia subject watersheds of this report is estimated to be 45,000 people.

Figure 3-1. Location of the Tug Fork River watershed TMDL Project Area in West Virginia

Landuse and land cover estimates were originally obtained from vegetation data gathered from the National Land Cover Dataset (NLCD) (USGS 2016). The Multi-Resolution Land Characteristics Consortium (MRLC) produced the NLCD coverage. The NLCD database for West Virginia was derived from satellite imagery taken during the mid-2000s, and it includes detailed vegetative spatial data. Enhancements and updates to the NLCD coverage were made to create a modeled landuse by custom edits derived primarily from WVDEP source tracking information and 2016 aerial photography with 1-meter resolution. Additional information regarding the NLCD spatial database is provided in **Appendix D** of the Technical Report.

Table 3-1 displays the landuse distribution for the West Virginia TMDL watersheds derived from NLCD as described above. The dominant landuse is forest, which constitutes 66.97 percent of the total landuse area. Other important modeled landuse types are mining/quarry (16.57 percent), forestry (5.29 percent), grassland (4.52 percent), urban/residential (3.78 percent), oil and gas (1.38 percent), and AML (1.04 percent). Individually, all other land cover types compose less than one percent of the total watershed area each.

Table 3-1. Modified landuse for the Tug Fork River TMDL watersheds

Landuse Type	Area of Watershed		
	Acres	Square Miles	West Virginia Percentage
AML	6,203.07	9.69	1.04%
Barren	228.4	0.36	0.04%
Cropland	30.78	0.05	0.01%
Forest	400,192.62	625.3	66.97%
Forestry	31,600.13	49.38	5.29%
Grassland	26,981.24	42.16	4.52%
Mining	98,999.34	154.69	16.57%
Oil and Gas	8,235.96	12.87	1.38%
Pasture	762.32	1.19	0.13%
Urban/Residential	22,586.21	35.29	3.78%
Water	1,755.75	2.74	0.29%
Kentucky	304,298.00	475.47	
Virginia	92,317.30	144.25	

3.2 Kentucky and Virginia Portions of the Tug Fork Watershed

Coordination between USEPA Region 3, USEPA Region 4, West Virginia, Kentucky, and Virginia state TMDL programs occurred prior to iron and fecal coliform TMDL development for the Tug Fork River mainstem. Pre-TMDL water quality monitoring at the mouths of seven major Kentucky tributaries indicated these streams contributed loads of iron and fecal coliform to Tug Fork River mainstem assessment units that should be accounted for in the TMDL. To best estimate daily loads and flows coming from Kentucky and Virginia, a watershed loading model was constructed with a stream network, weather inputs, and non-point source landuses derived from NLCD within the same modeling framework developed for West Virginia. For iron modeling, mining areas were incorporated into the model landuse using a GIS coverage of mine permit boundary areas. Mining boundaries were used to help inform the parameterization of the landcover, but no specific NPDES data were included in the model. Fecal coliform loads from failing septic systems were estimated using GIS data for addressable structures, soil properties, and stream network. Because high concentrations of iron and fecal coliform were observed in some Kentucky streams during pre-TMDL monitoring, reductions to iron and fecal coliform loads originating outside West Virginia were predicted to be necessary to meet West Virginia state water quality standards in Tug Fork River mainstem.

The TMDL allocation approach for the Tug Fork River mainstem was to first develop baseline and allocated TMDL conditions for impaired West Virginia tributary assessment units to address both impairments in the West Virginia tributaries themselves and the Tug Fork River mainstem. Then iron and fecal coliform sources originating outside West Virginia were reduced only to the degree necessary to allow West Virginia water quality standards to be met at the most downstream point of each subwatershed modeled reach segment of Tug Fork River mainstem. Kentucky and Virginia baseline and allocated loads are provided in the LAs tab of the iron and fecal coliform TMDL allocation sheets provided with this report.

Iron source reductions in Kentucky and Virginia tributary watersheds were necessary to meet West Virginia the iron water quality criterion in the Tug Fork mainstem. Kentucky and Virginia sources were reduced 35% across all landuses. An all-landuse reduction approach was chosen because iron source data in Kentucky and Virginia portion of the model lacked specific detail to support a top-down, subwatershed by subwatershed reduction approach. Starting with a 5% reduction, seven model runs were executed, increasing the reduction by 5% each time, to determine the minimum reduction needed to achieve the West Virginia criterion in the Tug mainstem. This method was used everywhere except in the Virginia headwaters of Horsepen Creek (WV-BST-98-AW-24) in subwatersheds 5090-5092 where Virginia mining sources received higher reductions to allow the West Virginia receiving streams to meet the TMDL endpoint. In these three subwatersheds, allocations were done in a stepwise manner with a total of 19 model runs to verify the minimum mining source reductions necessary to meet West Virginia TMDL endpoints.

Fecal coliform sources in Kentucky and Virginia were not reduced to meet West Virginia standards in out-of-state Tug tributaries, nor were they reduced to meet the state water quality standards of Kentucky or Virginia. Kentucky and Virginia reductions were generally less stringent than those applied to West Virginia watersheds. A standard reduction of 50% was applied to Kentucky and Virginia agricultural and residential sources, except a 75% reduction was necessary in Rockcastle Creek (subwatersheds 110-136) and a lesser reduction of 25% was necessary in Knox Creek (subwatersheds 257-289). These reductions were developed using a sequence of approximately 10 model runs with increasing percent reduction to determine the minimum reduction necessary in Kentucky tributaries. Three subwatersheds in the Virginia headwaters of Dry Fork (WV-BST-98) required higher than 50% reductions to agricultural sources in order for the downstream West Virginia portion of Dry Fork to meet TMDL endpoints. These reductions were developed with approximately 10 model runs specifically targeting the headwaters of Dry Fork. A standard 50% reduction to Kentucky and Virginia failing septic system sources was also assigned because this reduction, applied equally across every out of state subwatershed, would allow the Tug Fork mainstem to meet the West Virginia TMDL endpoint.

3.3 Data Inventory

Various sources of data were used in the TMDL development process. The data were used to identify and characterize sources of pollution and to establish the water quality response to those sources. Review of the data included a preliminary assessment of the watershed's physical and socioeconomic characteristics and current monitoring data. **Table 3-2** identifies the data used to support the TMDL assessment and modeling effort. These data describe the physical conditions of the TMDL watersheds, the potential pollutant sources and their contributions, and the impaired waterbodies for which TMDLs need to be developed. Prior to TMDL development, WVDEP collected comprehensive water quality data throughout the watershed. This pre-TMDL monitoring effort contributed the largest amount of water quality data to the process and is summarized in the Technical Report, **Appendix J**. The geographic information is provided in the ArcGIS Viewer Project.

Table 3-2. Datasets used in TMDL development

Type of Information		Data Sources
Watershed physiographic data	Stream network	USGS National Hydrography Dataset (NHD)
	Landuse	National Land Cover Dataset 2016 (NLCD)
	National Agriculture Imagery Program (NAIP) 2016 Aerial Photography (1-meter resolution)	U.S. Department of Agriculture (USDA)
	Counties	U.S. Census Bureau
	Cities/populated places	U.S. Census Bureau
	Soils	State Soil Geographic Database (STATSGO) USDA, Natural Resources Conservation Service (NRCS) soil surveys
	Hydrologic Unit Code boundaries	U.S. Geological Survey (USGS)
	Topographic and digital elevation models (DEMs)	National Elevation Dataset (NED)
	Dam locations	USGS
	Roads	2015 U.S. Census Bureau Topologically Integrated Geographic Encoding and Referencing database (TIGER), WVU WV Roads, West Virginia Trail Inventory (WVDOT)
	Water quality monitoring station locations	WVDEP
	Meteorological station locations	National Oceanic and Atmospheric Administration, National Climatic Data Center (NOAA-NCDC)

Type of Information		Data Sources
	Permitted facility information	WVDEP Division of Water and Waste Management (DWWM), WVDEP Division of Mining and Reclamation (DMR)
	Timber harvest data	WV Division of Forestry
	Oil and gas operations coverage	WVDEP Office of Oil and Gas (OOG)
	Abandoned mining coverage	WVDEP Office of Abandoned Mine Lands and Reclamation
Monitoring data	Historical Flow Record (daily averages)	USGS
	Rainfall	NOAA-NCDC
	Temperature	NOAA-NCDC
	Wind speed	NOAA-NCDC
	Dew point	NOAA-NCDC
	Humidity	NOAA-NCDC
	Cloud cover	NOAA-NCDC
	Grid-scale radar observations + climatologically-aided interpolation of complex climate regimes	Parameter-Elevation Regressions on Independent Slopes Model (PRISM), North American Land Data Assimilation System (NLDAS-2)
	Water quality monitoring data	WVDEP
	National Pollutant Discharge Elimination System (NPDES) data	WVDEP DMR, WVDEP DWWM
	Discharge Monitoring Report data	WVDEP DMR, Mining Companies
	Abandoned mine land data	WVDEP Office of Abandoned Mine Lands and Reclamation, WVDEP DWWM
Regulatory or policy information	Applicable water quality standards	WVDEP
	Section 303(d) list of impaired waterbodies	WVDEP, USEPA
	Nonpoint Source Management Plans	WVDEP

3.4 Impaired Waterbodies

WVDEP conducted extensive water quality monitoring throughout the Tug Fork River watershed from 2018 through 2019. Additional monitoring occurred on the Tug Fork mainstem and other selected streams in the first half of 2020. The results of that effort were used to confirm the impairments of waterbodies identified on previous 303(d) lists and to identify other impaired waterbodies that were not previously listed.

In this TMDL development effort, modeling at baseline conditions demonstrated additional pollutant impairments to those identified via monitoring. The prediction of impairment through modeling is validated by applicable federal guidance for 303(d) listing. WVDEP could not perform water quality monitoring and source characterization at frequencies or sample location resolution sufficient to comprehensively assess water quality under the terms of applicable water quality standards, and modeling was needed to complete the assessment. Where existing pollutant sources were confidently predicted to cause noncompliance with a particular criterion, the subject water was characterized as impaired for that pollutant.

TMDLs were developed for impaired waters in 88 TMDL watersheds (**Figure 3-2**). The impaired waters for which TMDLs have been developed are presented in **Table 3-3**. The table includes the TMDL watershed, stream code, stream name, and impairments for each stream.

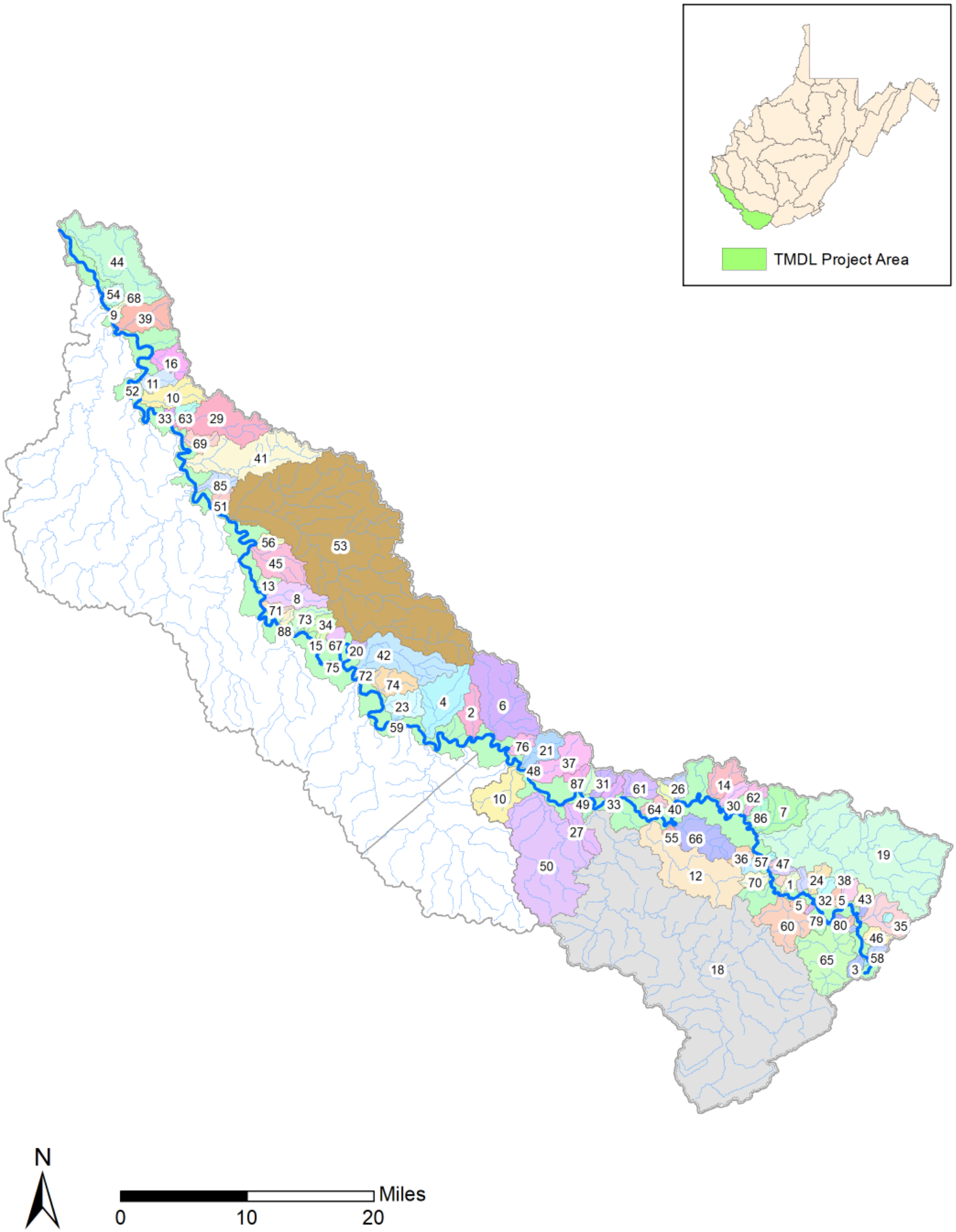


Figure 3-2. Tug Fork River TMDL Watersheds

Key	TMDL Watershed	Key	TMDL Watershed
1	Adkin Branch	45	Miller Creek
2	Alum Creek	46	Millseat Branch
3	Ballard Harmon Branch	47	Mitchell Branch
4	Beech Creek	48	Mohawk Branch
5	Belcher Branch	49	Negro Branch
6	Ben Creek	50	Panther Creek
7	Browns Creek	51	Parsley Big Branch
8	Buffalo Creek	52	Peters Branch
9	Bull Branch	53	Pigeon Creek
10	Bull Creek	54	Powdermill Branch
11	Camp Creek	55	River Laurel Branch
12	Clear Fork	56	Road Branch
13	Dans Branch	57	Rock Narrows Branch
14	Davy Branch	58	Sams Branch
15	Dick Williamson Branch	59	Sand Branch
16	Drag Creek	60	Sandlick Creek
17	Dry Branch	61	Sandy Huff Branch
18	Dry Fork	62	Shannon Branch
19	Elkhorn Creek	63	Silver Creek
20	Ferrell Branch	64	Snipe Branch
21	Fourpole Creek	65	South Fork/Tug Fork
22	Grapevine Branch	66	Spice Creek
23	Grapevine Creek	67	Sprouse Creek
24	Harmon Branch	68	Stone Branch
25	Harris Branch	69	Stonecoal Creek
26	Hensley Creek	70	Sugarcamp Branch
27	Horse Creek	71	Sugartree Creek
28	Jed Branch	72	Sulphur Creek
29	Jennie Creek	73	Sycamore Creek
30	Jenny Branch	74	Thacker Creek
31	Johnnycake Branch	75	Tug Fork
32	Leslie Branch	76	Turkey Creek
33	Lick Branch	77	Turnhole Branch
34	Lick Creek	78	UNT/Little Creek RM 2.34
35	Little Creek	79	UNT/Tug Fork RM 145.75
36	Little Indian Creek	80	UNT/Tug Fork RM 148.42
37	Longpole Creek	81	UNT/Tug Fork RM 148.86
38	Loop Branch	82	UNT/Tug Fork RM 152.09
39	Lost Creek	83	UNT/Tug Fork RM 154.02
40	Lower Hensley Creek	84	UNT/Tug Fork RM 157.07
41	Marrowbone Creek	85	Upper Burning Creek
42	Mate Creek	86	Upper Shannon Branch
43	Mill Branch	87	War Branch
44	Mill Creek	88	Williamson Creek

Table 3-3. Waterbodies and impairments for which TMDLs have been developed.

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Tug Fork	WV-BST_01	Tug Fork	WVBST			X				
Tug Fork	WV-BST_02	Tug Fork	WVBST			X	M			
Tug Fork	WV-BST_03	Tug Fork	WVBST			X				
Tug Fork	WV-BST_04	Tug Fork	WVBST			X	XRe			
Tug Fork	WV-BST_05	Tug Fork	WVBST			X	X			
Tug Fork	WV-BST_06	Tug Fork	WVBST			X	XRe			
Tug Fork	WV-BST_07	Tug Fork	WVBST			X	X			
Tug Fork	WV-BST_08	Tug Fork	WVBST			X	M			
Tug Fork	WV-BST_09	Tug Fork	WVBST			X	X			
Tug Fork	WV-BST_10	Tug Fork	WVBST			X	X			
Mill Creek	WV-BST-2_02	Mill Creek	WVBST-1			X	X			
Mill Creek	WV-BST-2_03	Mill Creek	WVBST-1			X	X			
Mill Creek	WV-BST-2-E_01	Paddle Creek	WVBST-1-A			X				
Mill Creek	WV-BST-2-S_01	Left Fork/Mill Creek	WVBST-1-E			X				
Mill Creek	WV-BST-2-S-6_01	Rush Branch	WVBST-1-E-3			X	X			
Mill Creek	WV-BST-2-T_01	Right Fork/Mill Creek	WVBST-1-D			X				
Mill Creek	WV-BST-2-T-5_01	Grassy Branch	WVBST-1-D-1				M			
Powdermill Branch	WV-BST-8_01	Powdermill Branch	WVBST-3			X	X			
Bull Branch	WV-BST-9_01	Bull Branch	WVBST-4				X			
Stone Branch	WV-BST-10_01	Stone Branch	WVBST-5			X	X			
Lost Creek	WV-BST-12_01	Lost Creek	WVBST-7			X				
Lost Creek	WV-BST-12_02	Lost Creek	WVBST-7			X				
Lost Creek	WV-BST-12-M_01	Right Fork/Lost Creek	WVBST-7-D			X				
Drag Creek	WV-BST-16_01	Drag Creek	WVBST-10			X	X			
Drag Creek	WV-BST-16-C_01	Painter Branch	WVBST-10-0.5A			X				
Camp Creek	WV-BST-18_01	Camp Creek	WVBST-12			X				

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Peters Branch	WV-BST-19_01	Peters Branch	WVBST-13			X				
Bull Creek	WV-BST-21_01	Bull Creek	WVBST-14			X				
Bull Creek	WV-BST-21_02	Bull Creek	WVBST-14			X	M			
Bull Creek	WV-BST-21-E_01	Right Fork/Bull Creek	WVBST-14-B			X				
Lick Branch	WV-BST-24_01	Lick Branch	WVBST-15			X	X			
Silver Creek	WV-BST-25_01	Silver Creek	WVBST-16			X				
Jennie Creek	WV-BST-26_01	Jennie Creek	WVBST-17			X	M			
Jennie Creek	WV-BST-26_02	Jennie Creek	WVBST-17			X	X			
Jennie Creek	WV-BST-26_03	Jennie Creek	WVBST-17			X	M			
Jennie Creek	WV-BST-26-M_01	Upper Honey Branch	WVBST-17-F				M			
Stonecoal Creek	WV-BST-27_01	Stonecoal Creek	WVBST-18			X	X			
Marrowbone Creek	WV-BST-29_02	Marrowbone Creek	WVBST-19			X	M			
Marrowbone Creek	WV-BST-29_03	Marrowbone Creek	WVBST-19			X	M			
Marrowbone Creek	WV-BST-29-A_01	Vinson Branch	WVBST-19-A				M			
Marrowbone Creek	WV-BST-29-C_01	Left Fork/Marrowbone Creek	WVBST-19-B				M			
Marrowbone Creek	WV-BST-29-J_01	Neely Branch	WVBST-19-F				M			
Marrowbone Creek	WV-BST-29-M_01	Laurel Branch	WVBST-19-I			X				
Marrowbone Creek	WV-BST-29-O_01	Antley Branch	WVBST-19-J			X				
Upper Burning Creek	WV-BST-32_01	Upper Burning Creek	WVBST-22				M			
Parsley Big Branch	WV-BST-33_01	Parsley Big Branch	WVBST-23			X	M			
Pigeon Creek	WV-BST-35_01	Pigeon Creek	WVBST-24				M			
Pigeon Creek	WV-BST-35_02	Pigeon Creek	WVBST-24				M			
Pigeon Creek	WV-BST-35_03	Pigeon Creek	WVBST-24			X	XRe			
Pigeon Creek	WV-BST-35_04	Pigeon Creek	WVBST-24			X	XRe			
Pigeon Creek	WV-BST-35_05	Pigeon Creek	WVBST-24				M			
Pigeon Creek	WV-BST-35_06	Pigeon Creek	WVBST-24			X	X			
Pigeon Creek	WV-BST-35-E_01	Big Branch	WVBST-24-B			X	M			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Pigeon Creek	WV-BST-35-J_01	Mill Branch	WVBST-24-D			X				
Pigeon Creek	WV-BST-35-K_02	Laurel Fork/Pigeon Creek	WVBST-24-E			X	M			
Pigeon Creek	WV-BST-35-K_03	Laurel Fork/Pigeon Creek	WVBST-24-E			X				
Pigeon Creek	WV-BST-35-K_04	Laurel Fork/Pigeon Creek	WVBST-24-E			X	M			
Pigeon Creek	WV-BST-35-K-1_01	Right Fork/Laurel Fork/Pigeon Creek	WVBST-24-E-1			X	M			
Pigeon Creek	WV-BST-35-K-1_02	Right Fork/Laurel Fork/Pigeon Creek	WVBST-24-E-1			X				
Pigeon Creek	WV-BST-35-K-1-F_01	Buck Branch	WVBST-24-E-1-B				M			
Pigeon Creek	WV-BST-35-K-1-H_01	Bubby Branch	WVBST-24-E-1-D				M			
Pigeon Creek	WV-BST-35-K-3_01	Spruce Fork	WVBST-24-E-2			X	M			
Pigeon Creek	WV-BST-35-K-3-A_01	Left Fork/Spruce Fork	WVBST-24-E-2-A				M			
Pigeon Creek	WV-BST-35-K-7_01	Rockhouse Branch	WVBST-24-E-5				M			
Pigeon Creek	WV-BST-35-K-10_01	Paw Paw Branch	WVBST-24-E-7				M			
Pigeon Creek	WV-BST-35-K-11_01	UNT/Laurel Fork RM 9.61	WVBST-24-E-7.3				M			
Pigeon Creek	WV-BST-35-K-16_01	Panther Branch	WVBST-24-E-8				M			
Pigeon Creek	WV-BST-35-M_01	Oldhouse Branch	WVBST-24-F.5			X				
Pigeon Creek	WV-BST-35-O_01	UNT/Pigeon Creek RM 6.72 (White Branch)	WVBST-24-G			X				
Pigeon Creek	WV-BST-35-P_01	Hensley Big Branch	WVBST-24-H			X				
Pigeon Creek	WV-BST-35-R_01	Ruth Trace Branch	WVBST-24-J			X				
Pigeon Creek	WV-BST-35-S_02	Trace Fork	WVBST-24-K				M			
Pigeon Creek	WV-BST-35-S_03	Trace Fork	WVBST-24-K			X	M			
Pigeon Creek	WV-BST-35-S-8_01	Riffe Branch	WVBST-24-K-2			X				
Pigeon Creek	WV-BST-35-S-10_01	Right Fork/Trace Fork	WVBST-24-K-4			X	M			
Pigeon Creek	WV-BST-35-S-10-B_01	Left Fork/Right Fork/Trace Fork	WVBST-24-K-4-A			X				
Pigeon Creek	WV-BST-35-S-13_01	Dingess Camp Branch	WVBST-24-K-7			X				
Pigeon Creek	WV-BST-35-S-15_01	Simmons Fork	WVBST-24-K-8			X				
Pigeon Creek	WV-BST-35-T_01	Conley Branch	WVBST-24-L			X				

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Pigeon Creek	WV-BST-35-V_01	Hell Creek	WVBST-24-M			X				
Pigeon Creek	WV-BST-35-Z_02	Elk Creek	WVBST-24-N			X	M			
Pigeon Creek	WV-BST-35-Z-6_01	Fivemile Creek	WVBST-24-N-2			X				
Pigeon Creek	WV-BST-35-Z-9_01	Middle Fork/Elk Creek	WVBST-24-N-5			X				
Pigeon Creek	WV-BST-35-Z-10_01	Left Fork/Elk Creek	WVBST-24-N-4				M			
Pigeon Creek	WV-BST-35-AA_01	Millstone Branch	WVBST-24-O			X	XRe			
Pigeon Creek	WV-BST-35-AC_01	Pigeonroost Creek	WVBST-24-P			X				
Pigeon Creek	WV-BST-35-AF_01	Rockhouse Fork	WVBST-24-Q				M			
Pigeon Creek	WV-BST-35-AF_03	Rockhouse Fork	WVBST-24-Q			X	M			
Pigeon Creek	WV-BST-35-AF-4_01	Upper Curry Branch	WVBST-24-Q-4				M			
Pigeon Creek	WV-BST-35-AF-6_01	South Branch/Rockhouse Fork	WVBST-24-Q-5			X				
Pigeon Creek	WV-BST-35-AF-7_01	Big Pigeonroost Branch	WVBST-24-Q-6			X	X			
Pigeon Creek	WV-BST-35-AF-11_01	Spring Branch	WVBST-24-Q-7				M			
Pigeon Creek	WV-BST-35-AG_01	Stonecoal Branch	WVBST-24-Q.5			X				
Pigeon Creek	WV-BST-35-AM_01	UNT/Pigeon Creek RM 20.01	WVBST-24-S.3				M		X	
Pigeon Creek	WV-BST-35-AS_01	Oldfield Branch	WVBST-24-T			X	X			
Pigeon Creek	WV-BST-35-AT_01	Bird Branch	WVBST-24-U			X				
Pigeon Creek	WV-BST-35-AX_01	Meador Branch	WVBST-24-W			X				
Pigeon Creek	WV-BST-35-BA_01	Rover Branch	WVBST-24-Z			X				
Pigeon Creek	WV-BST-35-BB_01	Slick Rock Branch	WVBST-24-AA			X				
Pigeon Creek	WV-BST-35-BC_01	Little Muncy Branch	WVBST-24-BB			X				
Pigeon Creek	WV-BST-35-BE_01	Grant Branch	WVBST-24-DD				X			
Pigeon Creek	WV-BST-35-BG_01	Thacker Fork	WVBST-24-FF				M			
Road Branch	WV-BST-38_01	Road Branch	WVBST-26				X			
Miller Creek	WV-BST-39_01	Miller Creek	WVBST-27				M			
Miller Creek	WV-BST-39_02	Miller Creek	WVBST-27				X			
Dans Branch	WV-BST-43_01	Dans Branch	WVBST-29			X	X			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Buffalo Creek	WV-BST-45_01	Buffalo Creek	WVBST-31			X	M			
Buffalo Creek	WV-BST-45-B_01	South Fork/Buffalo Creek	WVBST-31-B			X				
Sugartree Creek	WV-BST-46_01	Sugartree Creek	WVBST-32			X	XRe			
Williamson Creek	WV-BST-47_01	Williamson Creek	WVBST-33			X	XRe			
Sycamore Creek	WV-BST-48_01	Sycamore Creek	WVBST-34			X	M			
Lick Creek	WV-BST-49_01	Lick Creek	WVBST-35			X	X			
Lick Creek	WV-BST-49-C_01	UNT/Lick Creek RM 2.14					M			
Dick Williamson Branch	WV-BST-50_01	Dick Williamson Branch	WVBST-36			X	M			
Sprouse Creek	WV-BST-54_01	Sprouse Creek	WVBST-38				XRe			
Ferrell Branch	WV-BST-55_01	Ferrell Branch	WVBST-39				M			
Ferrell Branch	WV-BST-55-B_01	UNT/Ferrell Branch RM 0.83	WVBST-39-B				X			
Mate Creek	WV-BST-57_01	Mate Creek	WVBST-40				M			
Mate Creek	WV-BST-57_02	Mate Creek	WVBST-40			X	M			
Mate Creek	WV-BST-57_03	Mate Creek	WVBST-40			X	M			
Mate Creek	WV-BST-57-B_01	Rutherford Branch	WVBST-40-B			X	XRe			
Mate Creek	WV-BST-57-D_01	Mitchell Branch	WVBST-40-C			X	X			
Mate Creek	WV-BST-57-G_01	Chafin Branch	WVBST-40-D				XRe			
Mate Creek	WV-BST-57-K_01	Double Camp Fork	WVBST-40-H			X	M			
Mate Creek	WV-BST-57-K-1_01	UNT/Double Camp Fork RM 1.36					M			
Mate Creek	WV-BST-57-L_01	Straight Fork	WVBST-40-I				M			
Sulphur Creek	WV-BST-58_01	Sulphur Creek	WVBST-41			X	M			
Thacker Creek	WV-BST-61_01	Thacker Creek	WVBST-42				XRe	X	X	X
Thacker Creek	WV-BST-61-A_01	Scissorsville Branch	WVBST-42-A				XRe			
Thacker Creek	WV-BST-61-B_01	Mauchlinville Branch	WVBST-42-B				X			
Grapevine Creek	WV-BST-62_01	Grapevine Creek	WVBST-43				X			
Grapevine Creek	WV-BST-62-A_01	Lick Fork	WVBST-43-A				XRe			
Grapevine Creek	WV-BST-62-B_01	Wolfpen Fork	WVBST-43-B				M			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Grapevine Creek	WV-BST-62-C_01	Millseat Branch	WVBST-43-B.5				X			
Sand Branch	WV-BST-64_01	Sand Branch	WVBST-44				X			
Beech Creek	WV-BST-67_02	Beech Creek	WVBST-46			X				
Beech Creek	WV-BST-67-D_01	Grapevine Fork	WVBST-46-B			X	M			
Beech Creek	WV-BST-67-D-1_01	UNT/Grapevine Fork RM 0.22	WVBST-46-B-1			X	M			
Tug Fork	WV-BST-70_01	Laurel Branch	WVBST-49				M			
Alum Creek	WV-BST-72_01	Alum Creek	WVBST-50			X				
Ben Creek	WV-BST-74_01	Ben Creek	WVBST-52			X	M			
Ben Creek	WV-BST-74_02	Ben Creek	WVBST-52			X	M			
Ben Creek	WV-BST-74_03	Ben Creek	WVBST-52			X	X			
Ben Creek	WV-BST-74-D_01	Left Fork/Ben Creek	WVBST-52-B				M			
Ben Creek	WV-BST-74-D_02	Left Fork/Ben Creek	WVBST-52-B			X				
Ben Creek	WV-BST-74-L_01	White Oak Hollow	WVBST-52-G.5			X	M			
Turkey Creek	WV-BST-77_01	Turkey Creek	WVBST-55			X				
Fourpole Creek	WV-BST-78_01	Fourpole Creek	WVBST-56			X	M			
Fourpole Creek	WV-BST-78-B_01	UNT/Fourpole Creek RM 2.87	WVBST-56-A.4			X				
Bull Creek	WV-BST-79_01	Bull Creek	WVBST-57			X	X			
Bull Creek	WV-BST-79_02	Bull Creek	WVBST-57			X				
Bull Creek	WV-BST-79-D_01	Left Fork/Bull Creek	WVBST-57-B			X	X			
Bull Creek	WV-BST-79-J_01	UNT/Bull Creek RM 4.71	WVBST-57-G			X				
Mohawk Branch	WV-BST-80_01	Mohawk Branch	WVBST-58				M		M	M
Longpole Creek	WV-BST-81_02	Longpole Creek	WVBST-59			X				
Longpole Creek	WV-BST-81-J_01	Panther Fork	WVBST-59-B				M			
Panther Creek	WV-BST-83_03	Panther Creek	WVBST-60				XRe			
Panther Creek	WV-BST-83_04	Panther Creek	WVBST-60			X	XRe			
Panther Creek	WV-BST-83-A_01	Greenbrier Fork	WVBST-60-A			X				
Panther Creek	WV-BST-83-B_01	Trap Fork	WVBST-60-B			X				

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Panther Creek	WV-BST-83-C_01	Trace Fork	WVBST-60-C			X				
Panther Creek	WV-BST-83-E_01	Cub Branch	WVBST-60-D				XRe			
Panther Creek	WV-BST-83-I_01	Hurricane Branch	WVBST-60-G				M			
Panther Creek	WV-BST-83-P_01	Meathouse Fork	WVBST-60-H				M			
Horse Creek	WV-BST-88_01	Horse Creek	WVBST-63			X	M			
Horse Creek	WV-BST-88-D_01	UNT/Horse Creek RM 1.52					M			
War Branch	WV-BST-91_01	War Branch	WVBST-65			X	X			
Negro Branch	WV-BST-93_01	Negro Branch	WVBST-66			X				
Tug Fork	WV-BST-95_01	Rock Branch	WVBST-68				M			
Johnnycake Branch	WV-BST-96_01	Johnnycake Branch	WVBST-69			X				
Johnnycake Branch	WV-BST-96-C_01	UNT/Johnnycake Branch RM 1.76	WVBST-69-C			X	M			
Dry Fork	WV-BST-98_03	Dry Fork	WVBST-70	RM 31.3 to HW (Abv Canebrake)			M			
Dry Fork	WV-BST-98_04	Dry Fork	WVBST-70			X	M			
Dry Fork	WV-BST-98_05	Dry Fork	WVBST-70			X				
Dry Fork	WV-BST-98_06	Dry Fork	WVBST-70			X				
Dry Fork	WV-BST-98_07	Dry Fork	WVBST-70			X				
Dry Fork	WV-BST-98-A_01	Coon Branch	WVBST-70-A			X	X			
Dry Fork	WV-BST-98-H_01	Mile Branch	WVBST-70-C			X	M		M	
Dry Fork	WV-BST-98-H-2_01	UNT/Mile Branch RM 0.98	WVBST-70-C-2						M	M
Dry Fork	WV-BST-98-H-2-A_01	UNT/UNT RM 0.34/Mile Branch RM 0.98	WVBST-70-C-2-A						M	
Dry Fork	WV-BST-98-J_01	Crane Creek	WVBST-70-D			X				
Dry Fork	WV-BST-98-K_01	Betsy Branch	WVBST-70-E			X				
Dry Fork	WV-BST-98-L_01	Grapevine Branch	WVBST-70-F			X	X			
Dry Fork	WV-BST-98-O_01	Beartown Branch	WVBST-70-I			X	XRe			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Dry Fork	WV-BST-98-V_01	Oozley Branch	WVBST-70-L			X				
Dry Fork	WV-BST-98-W_01	Bradshaw Creek	WVBST-70-M			X				
Dry Fork	WV-BST-98-W_03	Bradshaw Creek	WVBST-70-M			X				
Dry Fork	WV-BST-98-W-6_01	Groundhog Branch	WVBST-70-M-1			X	M			
Dry Fork	WV-BST-98-W-8_01	Hite Fork	WVBST-70-M-2			X	X			
Dry Fork	WV-BST-98-W-8-A_01	Middle Fork/Hite Fork	WVBST-70-M-2-A				M			
Dry Fork	WV-BST-98-W-8-B_01	Dry Monday Branch	WVBST-70-M-2-B				M			
Dry Fork	WV-BST-98-W-10_01	Wolfpen Branch	WVBST-70-M-3			X	M			
Dry Fork	WV-BST-98-Z_01	Little Slate Creek	WVBST-70-N				M			
Dry Fork	WV-BST-98-Z_02	Little Slate Creek	WVBST-70-N			X				
Dry Fork	WV-BST-98-Z_03	Little Slate Creek	WVBST-70-N		X	X	M			
Dry Fork	WV-BST-98-Z-6_01	Right Fork/Little Slate Creek	WVBST-70-N-1				M			
Dry Fork	WV-BST-98-Z-13_01	Mudlick Branch	WVBST-70-N-2				M			
Dry Fork	WV-BST-98-AD_01	Atwell Branch	WVBST-70-O			X	XRe			
Dry Fork	WV-BST-98-AE_01	Johnnycake Hollow	WVBST-70-P			X				
Dry Fork	WV-BST-98-AF_01	Bartley Creek	WVBST-70-Q			X				
Dry Fork	WV-BST-98-AP_01	Pruett Branch	WVBST-70-S			X	M			
Dry Fork	WV-BST-98-AQ_01	Barrenshe Creek	WVBST-70-T				M			
Dry Fork	WV-BST-98-AQ_02	Barrenshe Creek	WVBST-70-T			X				
Dry Fork	WV-BST-98-AQ-5_01	Clear Fork Branch	WVBST-70-T-2			X	M			
Dry Fork	WV-BST-98-AT_02	War Creek	WVBST-70-U			X				
Dry Fork	WV-BST-98-AT-10_01	Big Branch	WVBST-70-U-1				M			
Dry Fork	WV-BST-98-AT-10-F_01	UNT/Big Branch RM 1.28	WVBST-70-U-1-F				M			
Dry Fork	WV-BST-98-AW_01	Jacobs Fork	WVBST-70-W			X				
Dry Fork	WV-BST-98-AW_03	Jacobs Fork	WVBST-70-W			X	M			
Dry Fork	WV-BST-98-AW_04	Jacobs Fork	WVBST-70-W			X	M			
Dry Fork	WV-BST-98-AW_05	Jacobs Fork	WVBST-70-W			X				

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Dry Fork	WV-BST-98-AW-3_03	Big Creek	WVBST-70-W-1			X				
Dry Fork	WV-BST-98-AW-3-E_01	UNT/Big Creek RM 1.98	WVBST-70-W-1-0.7A				M			
Dry Fork	WV-BST-98-AW-3-F_01	Mountain Fork	WVBST-70-W-1-A				M			
Dry Fork	WV-BST-98-AW-3-Z_01	Middle Fork/Big Creek	WVBST-70-W-1-G				M			
Dry Fork	WV-BST-98-AW-10_01	Cucumber Creek	WVBST-70-W-5			X				
Dry Fork	WV-BST-98-AW-24_02	Horsepen Creek	WVBST-70-W-6			X				
Dry Fork	WV-BST-98-AW-24-C_01	UNT/Horsepen Creek RM 1.48	WVBST-70-W-6-0.5A			X	X			
Dry Fork	WV-BST-98-AW-24-K_01	Low Gap Branch	WVBST-70-W-6-B				M			
Dry Fork	WV-BST-98-BO_03	Beech Fork	WVBST-70-AA				M			
Dry Fork	WV-BST-98-BO-1_01	31 Hollow (Right Fork/Beech Fork)	WVBST-70-AA-1				M			
Lick Branch	WV-BST-100_01	Lick Branch	WVBST-71			X	M			
Tug Fork	WV-BST-101_01	Harman Branch	WVBST-72				M			
Sandy Huff Branch	WV-BST-102_01	Sandy Huff Branch	WVBST-73			X				
Snipe Branch	WV-BST-104_01	Snipe Branch	WVBST-75			X				
Clear Fork	WV-BST-106_01	Clear Fork	WVBST-76			X	XRe			
Clear Fork	WV-BST-106_02	Clear Fork	WVBST-76			X	XRe			
Clear Fork	WV-BST-106_03	Clear Fork	WVBST-76			X	X			
Clear Fork	WV-BST-106-M_01	Crane Trace Branch	WVBST-76-C				M			
Clear Fork	WV-BST-106-Q_01	Daycamp Branch	WVBST-76-E				M			
Clear Fork	WV-BST-106-Y_01	Wolfpen Branch	WVBST-76-I			X				
River Laurel Branch	WV-BST-108_01	River Laurel Branch	WVBST-77			X				
Spice Creek	WV-BST-109_01	Spice Creek	WVBST-78			X	M			
Spice Creek	WV-BST-109_02	Spice Creek	WVBST-78			X	X			
Spice Creek	WV-BST-109-A_01	Shabbyroom Branch	WVBST-78-B			X	XRe			
Spice Creek	WV-BST-109-G_01	Honeycamp Branch	WVBST-78-D				XRe			
Spice Creek	WV-BST-109-H_01	Coontree Branch	WVBST-78-E			X	XRe			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Spice Creek	WV-BST-109-I_01	Stonecoal Branch	WVBST-78-F				XRe			
Spice Creek	WV-BST-109-J_01	Badway Branch	WVBST-78-G			X	XRe			
Spice Creek	WV-BST-109-L_01	Newson Branch	WVBST-78-H			X	X			
Spice Creek	WV-BST-109-M_01	Moorecamp Branch	WVBST-78-I			X	XRe			
Lower Hensley Creek	WV-BST-115_01	Lower Hensley Creek	WVBST-79			X				
Hensley Creek	WV-BST-116_01	Hensley Creek	WVBST-80			X				
Tug Fork	WV-BST-121_01	Twin Branch	WVBST-84				M			
Davy Branch	WV-BST-123_01	Davy Branch	WVBST-85			X	M			
Davy Branch	WV-BST-123-A_01	Left Fork/Davy Branch	WVBST-85-A			X	XRe			
Davy Branch	WV-BST-123-G_01	UNT/Davy Branch RM 3.28	WVBST-85-G			X	X			
Jenny Branch	WV-BST-125_01	Jenny Branch	WVBST-87			X				
Shannon Branch	WV-BST-132_01	Shannon Branch	WVBST-94			X	X			
Upper Shannon Branch	WV-BST-133_01	Upper Shannon Branch	WVBST-95			X	XRe			
Browns Creek	WV-BST-137_01	Browns Creek	WVBST-98			X				
Browns Creek	WV-BST-137_02	Browns Creek	WVBST-98			X	M			
Browns Creek	WV-BST-137-D_01	Puncheoncamp Branch	WVBST-98-A			X	XRe			
Browns Creek	WV-BST-137-H_01	Trail Fork	WVBST-98-B			X	X			
Elkhorn Creek	WV-BST-138_01	Elkhorn Creek	WVBST-99	ENTIRE		X	X			
Elkhorn Creek	WV-BST-138_03	Elkhorn Creek	WVBST-99	ENTIRE		X	M			
Elkhorn Creek	WV-BST-138_04	Elkhorn Creek	WVBST-99	ENTIRE		X	X			
Elkhorn Creek	WV-BST-138_05	Elkhorn Creek	WVBST-99	ENTIRE		X	X			
Elkhorn Creek	WV-BST-138-E_01	Mill Creek	WVBST-99-A				M			
Elkhorn Creek	WV-BST-138-O_01	Laurel Branch	WVBST-99-E			X	X			
Elkhorn Creek	WV-BST-138-P_01	Rockhouse Branch	WVBST-99-F				X			
Elkhorn Creek	WV-BST-138-Q_01	Bottom Creek	WVBST-99-G			X	X			
Elkhorn Creek	WV-BST-138-Q-3_01	UNT/Bottom Creek RM 2.88					M			
Elkhorn Creek	WV-BST-138-V_01	Coalbank Branch	WVBST-99-I			X	X			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Elkhorn Creek	WV-BST-138-V-2_01	UNT/Coalbank Branch RM 0.58	WVBST-99-I-0.6				X			
Elkhorn Creek	WV-BST-138-V-3_01	UNT/Coalbank Branch RM 0.82	WVBST-99-I-0.7			X	X			
Elkhorn Creek	WV-BST-138-V-4_01	Dans Branch	WVBST-99-I-1				M			
Elkhorn Creek	WV-BST-138-V-5_01	UNT/Coalbank Branch RM 1.43	WVBST-99-I-2			X	X			
Elkhorn Creek	WV-BST-138-X_01	Burk Creek	WVBST-99-K				M			
Elkhorn Creek	WV-BST-138-X-1_01	UNT/Burk Creek RM 0.72					M			
Elkhorn Creek	WV-BST-138-Z_01	North Fork/Elkhorn Creek	WVBST-99-L			X	M			
Elkhorn Creek	WV-BST-138-Z_03	North Fork/Elkhorn Creek	WVBST-99-L			X				
Elkhorn Creek	WV-BST-138-Z-1_01	Buzzard Branch	WVBST-99-L-1				M			
Elkhorn Creek	WV-BST-138-Z-3_01	Bearwallow Branch	WVBST-99-L-2			X	M			
Elkhorn Creek	WV-BST-138-Z-5_01	Greenbrier Hollow (Leftwich Branch)	WVBST-99-L-3			X				
Elkhorn Creek	WV-BST-138-Z-6_01	Windmill Gap Branch	WVBST-99-L-4			X				
Elkhorn Creek	WV-BST-138-AJ_01	UNT/Elkhorn Creek RM 20.15	WVBST-99-O.7			X	X			
Elkhorn Creek	WV-BST-138-AH_01	Johns Knob Branch	WVBST-99-O				M			
Elkhorn Creek	WV-BST-138-AM_01	Angle Hollow	WVBST-99-Q				M			
Elkhorn Creek	WV-BST-138-AM-1_01	Little Fork	WVBST-99-Q-1				M			
Little Indian Creek	WV-BST-139_01	Little Indian Creek	WVBST-100			X	XRe			
Jed Branch	WV-BST-142_01	Jed Branch	WVBST-102				XRe			
Rock Narrows Branch	WV-BST-143_01	Rock Narrows Branch	WVBST-103				XRe			
Harris Branch	WV-BST-144_01	Harris Branch	WVBST-104				X			
Mitchell Branch	WV-BST-146_01	Mitchell Branch	WVBST-105			X	XRe			
Sugarcamp Branch	WV-BST-147_01	Sugarcamp Branch	WVBST-106				XRe			
Grapevine Branch	WV-BST-149_01	Grapevine Branch	WVBST-107				X			
Tug Fork	WV-BST-150_01	Mill Creek	WVBST-108				M			
Sandlick Creek	WV-BST-152_01	Sandlick Creek	WVBST-109				XRe			
Sandlick Creek	WV-BST-152_02	Sandlick Creek	WVBST-109			X	XRe			
Sandlick Creek	WV-BST-152-A_01	Right Fork/Sandlick Creek	WVBST-109-A			X	XRe			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Sandlick Creek	WV-BST-152-B_01	UNT/Sandlick Creek RM 1.61					M			
Sandlick Creek	WV-BST-152-C_01	Left Fork/Sandlick Creek	WVBST-109-B				XRe			
Sandlick Creek	WV-BST-152-C-3_01	UNT/Left Fork RM 0.89/Sandlick Creek	WVBST-109-B-3				X			
Sandlick Creek	WV-BST-152-C-3-A_01	UNT/UNT RM 0.01/Left Fork RM 0.89/Sandlick Creek	WVBST-109-B-3-A						X	
Sandlick Creek	WV-BST-152-E_01	UNT/Sandlick Creek RM 3.00	WVBST-109-D			X				
Adkin Branch	WV-BST-153_01	Adkin Branch	WVBST-110				XRe			
Belcher Branch	WV-BST-154_01	Belcher Branch	WVBST-111				XRe			
Turnhole Branch	WV-BST-155_01	Turnhole Branch	WVBST-112				XRe			
Harmon Branch	WV-BST-156_01	Harmon Branch	WVBST-113				XRe			
Leslie Branch	WV-BST-157_01	Leslie Branch	WVBST-114			X	X			
South Fork/Tug Fork	WV-BST-163_01	South Fork/Tug Fork	WVBST-115			X	X			
South Fork/Tug Fork	WV-BST-163_02	South Fork/Tug Fork	WVBST-115				XRe			
South Fork/Tug Fork	WV-BST-163_03	South Fork/Tug Fork	WVBST-115			X	XRe			
South Fork/Tug Fork	WV-BST-163-B_01	Tea Branch	WVBST-115-A			X	XRe			
South Fork/Tug Fork	WV-BST-163-D_01	McClure Branch	WVBST-115-B				XRe			
South Fork/Tug Fork	WV-BST-163-E_01	Milam Branch	WVBST-115-C				M			
South Fork/Tug Fork	WV-BST-163-F_01	Jump Branch	WVBST-115-D			X	XRe			
South Fork/Tug Fork	WV-BST-163-G_01	Spice Creek	WVBST-115-E				XRe			
South Fork/Tug Fork	WV-BST-163-J_01	Laurel Branch	WVBST-115-F			X	XRe			
South Fork/Tug Fork	WV-BST-163-K_01	Road Fork	WVBST-115-G				X			
South Fork/Tug Fork	WV-BST-163-M-1_01	UNT/UNT RM 0.04/South Fork RM 5.46/Tug Fork	WVBST-115-I-1				X			
South Fork/Tug Fork	WV-BST-163-N_01	UNT/South Fork RM 5.85/Tug Fork	WVBST-115-J			X				
South Fork/Tug Fork	WV-BST-163-N-1_01	UNT/UNT RM 0.15/South Fork RM 5.85/Tug Fork	WVBST-115-J-1				X			
UNT/Tug Fork RM 148.42	WV-BST-164_01	UNT/Tug Fork RM 148.42	WVBST-115.2			X				
Belcher Branch	WV-BST-166_01	Belcher Branch	WVBST-116				XRe			

TMDL Watershed	AUID NHD Code	Stream Name	WV Code	Trout	DO	FC	Fe	Mn	pH	Al
Loop Branch	WV-BST-168_01	Loop Branch	WVBST-117			X	X			
Mill Branch	WV-BST-170_01	Mill Branch	WVBST-118				XRe			
UNT/Tug Fork RM 152.09	WV-BST-172_01	UNT/Tug Fork RM 152.09	WVBST-118.7			X				
Dry Branch	WV-BST-173_01	Dry Branch	WVBST-119				XRe			
Little Creek	WV-BST-174_01	Little Creek	WVBST-120			X	XRe			
Little Creek	WV-BST-174-B_01	Indian Grave Branch	WVBST-120-A			X	X			
Little Creek	WV-BST-174-C_01	Puncheoncamp Branch	WVBST-120-B			X	XRe			
UNT/Little Creek RM 2.34	WV-BST-174-E_01	UNT/Little Creek RM 2.34					M			
UNT/Tug Fork RM 154.02	WV-BST-176_01	UNT/Tug Fork RM 154.02	WVBST-120.3			X				
Millseat Branch	WV-BST-178_01	Millseat Branch	WVBST-121			X	XRe			
Ballard Harmon Branch	WV-BST-179_01	Ballard Harmon Branch	WVBST-122			X	XRe			
Sams Branch	WV-BST-181_01	Sams Branch	WVBST-123			X	XRe			

Note:
RM river mile
UNT unnamed tributary
Al aluminum impairment
DO dissolved oxygen impairment
FC fecal coliform bacteria impairment
Fe iron impairment
Mn manganese impairment
pH acidity impairment
M impairment determined via modeling
X impairment determined via sampling
X-Re re-do of previous TMDL

4.0 BIOLOGICAL IMPAIRMENT AND STRESSOR IDENTIFICATION

The narrative water quality criterion of 47 CSR 2 §3.2.i prohibits the presence of wastes in State waters that cause or contribute to significant adverse impact to the chemical, physical, hydrologic, or biological components of aquatic ecosystems. Historically, WVDEP based assessment of biological integrity on a rating of the stream's benthic macroinvertebrate community using the multimetric West Virginia Stream Condition Index (WVSCI). WVSCI-based "biological impairments" were included on West Virginia's Section 303(d) lists from 2002 through 2010. In 2012, legislative action (codified in §22-11-7b) directed the agency to develop and secure legislative approval of new rules to interpret the narrative criterion for biological impairment found in 47 CSR 2-3.2.i.

§22-11-7b indicates, rules promulgated may not establish measurements that would establish standards less protective than requirements that existed during the 2012 regular session. Thus, WVDEP has continued to list biological impairment based on WVSCI for subsequent 303d lists, including the most recent approved list in 2016. In response to the legislation, WVDEP prepared a procedural rule (47 CSR 2B) establishing the methodology for determining compliance with the biological component of narrative criteria. A public comment period extended through May 6, 2019 and a public hearing was held the same day. Response to comment and final filing was delayed, requiring that the same procedural rule be proposed again in 2020. The public comment period ran through April 20, 2020 and a public hearing was held the same day. As with the 2019 rule, the final filing was delayed in 2020 resulting in a third version of the procedural rule in 2021 with a comment period ending on March 26, 2021. The procedural rule was not finalized.

The above notwithstanding, streams for which available benthic information demonstrates non-attainment of the threshold described in the assessment methodology presented in the *Aquatic Life Use Assessment and Biological Stressor Identification Procedure, August 2021* (**Appendix K** of the Technical Report) were subjected to the biological stressor identification (SI) process described in this section. The biological SI process allowed stream-specific identification of the significant stressors associated with benthic macroinvertebrate community impact. If those stressors are resolved through the attainment of numeric water quality criteria, and TMDLs addressing such criteria are developed and approved, then additional "biological TMDL" development work is not needed. SI results are presented for streams with benthic macroinvertebrate impacts in **Appendix K** of the Technical Report, so that they may be considered in listing/delisting decision-making in future 303(d) processes. This project does not include "biological impairment" TMDLs. However, the SI process demonstrated that biological stress would be resolved in 14 assessment units (14 streams) through the implementation of numeric criterion TMDLs developed in this project.

4.1 Introduction

Impacts to benthic macroinvertebrate communities were rated using a multimetric index developed for use in the wadeable streams of West Virginia. The WVSCI (Gerritsen et al., 2000) was designed to identify streams with benthic communities that differ from the reference condition presumed to constitute biological integrity. WVSCI is composed of six metrics that were selected to maximize discrimination between streams with known impairments and reference streams. Streams are assessed using WVSCI if the data was comparable (e.g., collected utilizing the same methods used to develop the WVSCI, adequate flow in riffle/run habitat, and within the index period). A WVSCI score of 72 (representing the 5^{th} percentile of reference scores) is considered the attainment threshold. Streams with WVSCI scores less than 72 were included in the SI process to identify significant stressors associated with impacts to aquatic life.

USEPA developed *Stressor Identification: Technical Guidance Document* (Cormier et al., 2000) to assist water resource managers in identifying stressors and stressor combinations that cause biological impact. Elements of that guidance were used and custom analyses of biological data were performed to supplement the recommended framework.

The general SI process entailed reviewing available information, forming and analyzing possible stressor scenarios, and implicating causative stressors. The SI method provides a consistent process for evaluating available information. **Section 7** of the Technical Report discusses biological impairment and the SI process in detail.

4.2 Data Review

WVDEP generated the primary data used in SI through its pre-TMDL monitoring program. The program included water quality monitoring, benthic sampling, and habitat assessment. In addition, the biologists' comments regarding stream condition and potential stressors and sources were captured and considered. Other data sources were: source tracking data, WVDEP mining activities data, NLCD 2016 landuse information, Natural Resources Conservation Service (NRCS) State Soil Geographic database (STATSGO) soils data, National Pollutant Discharge Elimination System (NPDES) point source data, and literature sources.

4.3 Candidate Causes/Pathways

The first step in the SI process was to develop a list of candidate causes, or stressors. The candidate causes considered are listed below:

1. Metals contamination (including metals contributed through soil erosion) causes toxicity
2. Acidity (low pH <6) causes toxicity
3. Basic (high pH >9) causes toxicity
4. Increased ionic strength causes toxicity
5. Increased total suspended solids (TSS)/erosion and altered hydrology cause sedimentation and other habitat alterations
6. Increased metals flocculation and deposition causes habitat alterations (e.g., embeddedness)
7. Organic enrichment (e.g. sewage discharges and agricultural runoff cause habitat alterations)
8. Altered hydrology causes higher water temperature, resulting in direct impacts

9. Altered hydrology, nutrient enrichment, and increased biochemical oxygen demand (BOD) cause reduced dissolved oxygen (DO)
10. Algal growth causes food supply shift
11. High levels of ammonia cause toxicity (including increased toxicity due to algal growth)
12. Chemical spills cause toxicity

A conceptual model was developed to examine the relationship between candidate causes and potential biological effects. The conceptual model (**Figure 4-1**) depicts the sources, stressors, and pathways that affect the biological community (USEPA 2010).

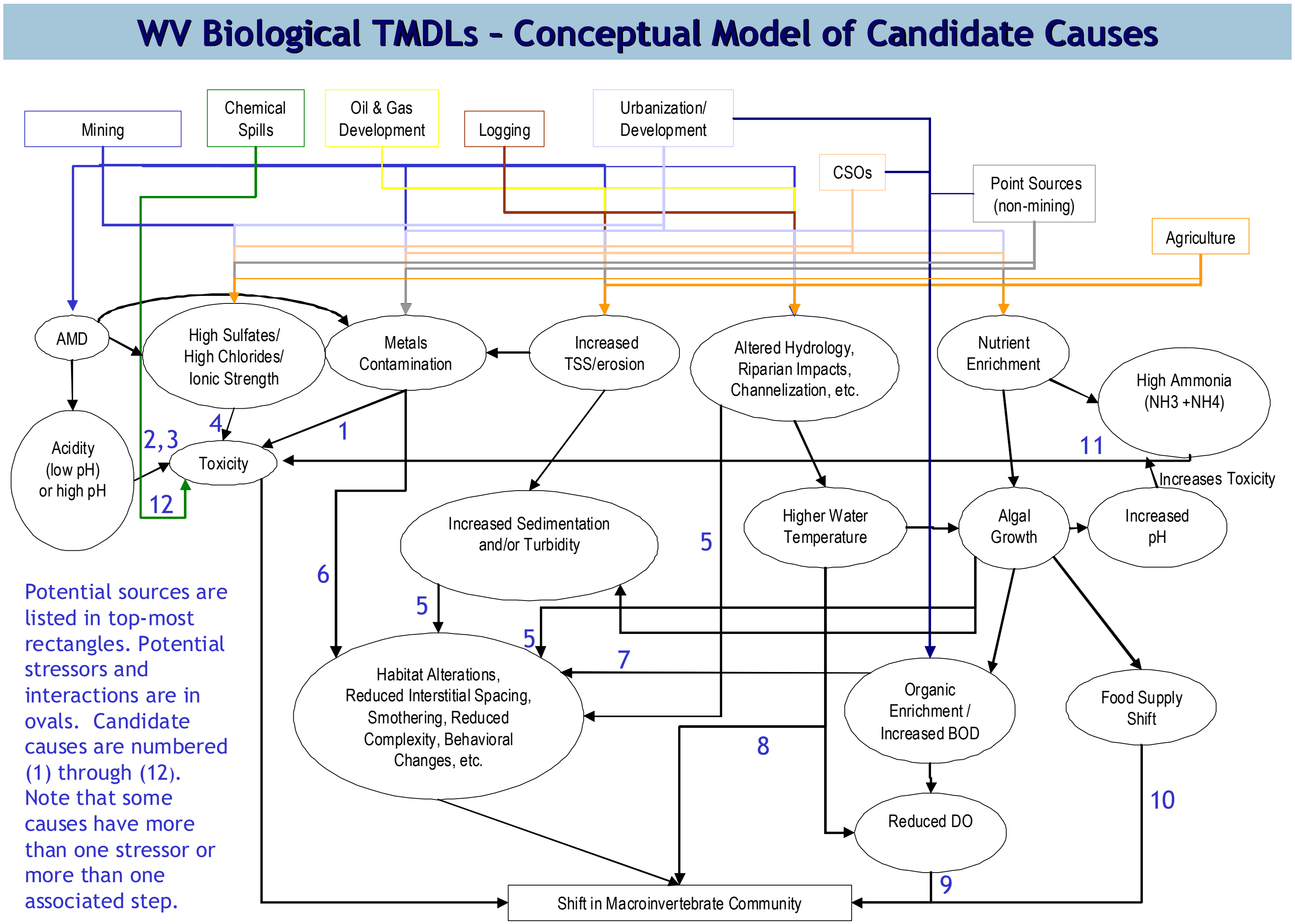


Figure 4-1. Conceptual model of candidate causes and potential biological effects

4.4 Stressor Identification Results

The SI process identified significant biological stressors for each assessment unit. Biological impact was linked to a single stressor in some cases and multiple stressors in others. The SI process identified the following stressors as present in the impacted waters in the Tug Fork River watershed:

- Organic enrichment (the combined effects of oxygen-demanding pollutants, and the resultant algal and habitat alteration)
- Sedimentation
- Low pH
- Dissolved metals
- Metals flocculants
- Ionic strength

After stressors were identified, WVDEP also determined the pollutants in need of control to address the impacts. In all streams for which the SI process identified organic enrichment as a significant biological stressor, data also indicated violations of the fecal coliform water quality criteria. The predominant sources of both organic enrichment and fecal coliform bacteria in the Tug Fork River Watershed are inadequately treated sewage. WVDEP determined that implementation of fecal coliform TMDLs would remove untreated sewage and thereby resolve organic enrichment stress.

There is a relationship between iron and sediment in West Virginia because there is a high iron content in soils and geology. Total iron is delivered to streams through erosion and sedimentation. Certain streams for which the SI process identified sedimentation as a significant stressor are also impaired pursuant to total iron water quality criteria. The TMDL assessment for iron included representation and allocation of iron loadings associated with sediment. WVDEP compared the amount of sediment reduction necessary in the iron TMDLs to the amount of reduction needed to achieve the normalized sediment loading of an unimpacted reference stream. In these streams, the sediment loading reduction necessary for attainment of water quality criteria for iron exceeds that which was determined to be necessary using the reference approach. Implementation of the iron TMDLs will resolve biological stress from sedimentation in these streams. See the Technical Report for further descriptions of the correlation between sediment and iron and the comparisons of sediment reductions under iron criterion attainment and reference watershed approaches.

The streams for which biological stress to benthic macroinvertebrates would be resolved through the implementation of the pollutant-specific TMDLs developed in this project are presented in **Table 4-1**. There are 83 assessment units (71 streams) for which the SI process did not indicate that TMDLs for numeric criteria would resolve the biological impacts. These streams are listed in **Appendix K**.

Table 4-1. Biological impacts resolved by implementation of pollutant-specific TMDLs

Assessment Unit ID	Stream Name	WV Code	Significant Stressors	TMDLs Developed
WV-BST-2-S-6_01	Rush Branch	WVBST-1-E-3	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-16_01	Drag Creek	WVBST-10	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-26_03	Jennie Creek	WVBST-17	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-33_01	Parsley Big Branch	WVBST-23	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-78_01	Fourpole Creek	WVBST-56	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-83_04	Panther Creek	WVBST-60	Organic Enrichment	Fecal Coliform
WV-BST-88_01	Horse Creek	WVBST-63	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-98-L_01	Grapevine Branch	WVBST-70-F	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-98-W-6_01	Groundhog Branch	WVBST-70-M-1	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-98-AW-3-F_01	Mountain Fork	WVBST-70-W-1-A	Sediment	Total Iron
WV-BST-106_01	Clear Fork	WVBST-76	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-109-A_01	Shabbyroom Branch	WVBST-78-B	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-138-O_01	Laurel Branch	WVBST-99-E	Sediment, Organic Enrichment	Total Iron, Fecal Coliform
WV-BST-138-Z_01	North Fork/Elkhorn Creek	WVBST-99-L	Sediment, Organic Enrichment	Total Iron, Fecal Coliform

5.0 METALS SOURCE ASSESSMENT

This section identifies and examines the potential sources of metals impairments in the Tug Fork River watershed. Sources can be classified as point (permitted) or nonpoint (non-permitted) sources. For the sake of consistency, the same modeled landuse setup was used for all metals nonpoint sources. Non-mining point sources were also modeled consistently in terms of drainage area and flow, although chemical concentrations (e.g. iron, TSS) were configured specifically for different pollutant sources.

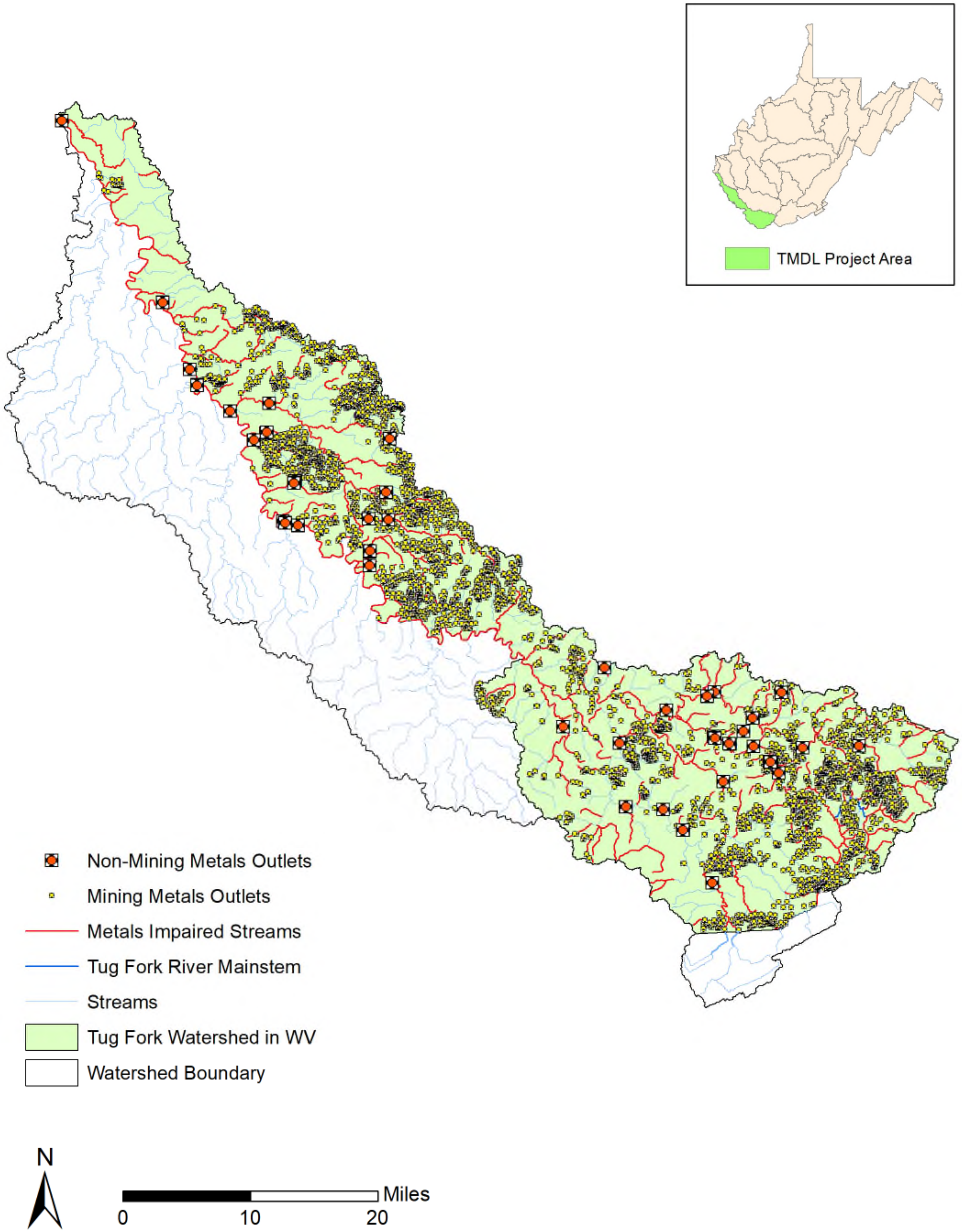
A point source, according to 40 CFR 122.3, is any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, and vessel or other floating craft from which pollutants are or may be discharged. The NPDES program, established under Clean Water Act Sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources. For purposes of this TMDL, NPDES-permitted discharge points are considered point sources. Municipal Separate Storm Sewer Systems (MS4) are also considered point sources.

Nonpoint sources of pollutants are diffuse, non-permitted sources and they most often result from precipitation-driven runoff. For the purposes of these TMDLs only, WLAs are given to NPDES-permitted discharge points, and LAs are given to discharges from activities that do not have an associated NPDES permit, such as nonpoint source pollution associated with oil and gas wells permitted through the WVDEP Office of Oil and Gas (OOG). The assignment of LAs to OOG permitted wells does not reflect any determination by WVDEP or USEPA as to whether there are, in fact, unpermitted point source discharges within this landuse. Likewise, by establishing these TMDLs with OOG permitted discharges treated as LAs, WVDEP and USEPA are not determining that these discharges are exempt from NPDES permitting requirements.

The physiographic data discussed in **Section 3.2** enabled the characterization of pollutant sources. As part of the TMDL development process, WVDEP performed additional field-based source tracking activities to supplement the available source characterization data. WVDEP staff recorded physical descriptions of pollutant sources and the general stream condition in the vicinity of the sources. WVDEP collected global positioning system (GPS) data and water quality samples for laboratory analysis as necessary to characterize the sources and their impacts. Source tracking information was compiled and electronically plotted on maps using GIS software. Detailed information, including the locations of pollutant sources, is provided in the following sections, the Technical Report, and the ArcGIS Viewer Project.

5.1 Metals Point Sources

Metals point sources are classified by the type of permits issued by WVDEP. The following sections discuss the potential impacts and the characterization of these source types, the locations of which are displayed in **Figure 5-1**.



(Note: outlets in close proximity appear to overlap in the figure)

Figure 5-1. Point sources in the Tug Fork River Watershed

5.1.1 Mining Point Sources

The Surface Mining Control and Reclamation Act of 1977 (SMCRA, Public Law 95-87) and its subsequent revisions were enacted to establish a nationwide program to protect the beneficial uses of land or water resources, protect public health and safety from the adverse effects of current surface coal mining operations, and promote the reclamation of mined areas left without adequate reclamation prior to August 3, 1977. SMCRA requires a permit for development of new, previously mined, or abandoned sites for the purpose of surface mining. Permittees are required to post a performance bond that will be sufficient to ensure the completion of reclamation requirements by a regulatory authority in the event that the applicant forfeits its permit. When a bond is forfeited, WVDEP assumes the responsibility for the reclamation requirements. In past TMDLs, bond forfeiture sites were classified as nonpoint sources. The judicial decision, West Virginia Highlands Conservancy, Inc., and West Virginia Rivers Coalition, Inc. v. Randy Huffman, Secretary, West Virginia Department of Environmental Protection. [1:07CV87]. 2009, requires WVDEP to obtain an NPDES permit for discharges from forfeited sites. As such, this project classifies bond forfeiture sites as point sources and provides WLAs.

Mines that ceased operations before the effective date of SMCRA (often called “pre-law” mines) are not subject to the requirements of the SMCRA.

SMCRA Title IV is designed to provide assistance for the reclamation and restoration of abandoned mines; whereas Title V states that any surface coal mining operations must be required to meet all applicable performance standards. Some general performance standards include the following:

- Restoring the affected land to a condition capable of supporting the uses that it was capable of supporting prior to any mining
- Backfilling and compacting (to ensure stability or to prevent leaching of toxic materials) to restore the approximate original contour of the land, including all highwalls
- Minimizing disturbances to the hydrologic balance and to the quality and quantity of water in surface water and groundwater systems both during and after surface coal mining operations and during reclamation by avoiding acid or other toxic mine drainage

Untreated mining-related point source discharges from deep, surface, and commingled mines may have low pH values (i.e., acidic) and contain high concentrations of metals (e.g., iron and aluminum). Mining-related activities are commonly issued NPDES discharge permits that contain effluent limits for total iron, total manganese, total suspended solids, and pH. Many permits also include effluent monitoring requirements for total aluminum and some more recently issued permits include aluminum water quality based effluent limits. WVDEP’s Division of Mining and Reclamation (DMR) provided a spatial coverage of the mining-related NPDES permit outlets. The discharge characteristics, related permit limits, and discharge data for these NPDES outlets were acquired from West Virginia’s ERIS database system. The spatial coverage was used to determine the location of the permit outlets. Additional information was needed, however, to determine the areas of the mining activities. WVDEP DMR also provided spatial coverage of the mining permit areas and related SMCRA Article 3 and NPDES permit information. WVDEP DWWM personnel used the information contained in the SMCRA Article 3 and NPDES permits to further characterize the mining point sources. Information gathered included type of discharge, pump capacities, and drainage areas (including total and disturbed areas).

The permitted mining point sources (open NPDES outlets) were grouped into landuse categories based on the type and status of mining activity and effluent discharge characteristics. Commingled discharges contain effluent discharges from both surface and deep mining activities. Surface mines, and commingled surface mines were treated as land-based precipitation-induced sources. The deep mine portions of commingled mines were characterized as continuous flow point sources. Deep mines were also characterized as continuous flow point sources.

There are 255 mining-related NPDES permits, with 2,179 active associated outlets in the metals impaired watersheds of the Tug Fork River watershed (Appendix F, HPU Outlets Metals Calls Tab). Point sources are represented differently during model calibration than they were during the allocation process. To match model results to historical water quality data for calibration, it is necessary to represent the existing point sources using available historical data. During the allocation process, permitted sources are represented at their allowable permit limits in the baseline condition. Reductions are made to the baseline when necessary to attain the TMDL endpoint in the allocated condition.

For metals modeling, ended outlets of open NPDES permits, outlets of NPDES permits with Post Mining Area requirements and all outlets of closed NPDES permits were represented as background loadings because reclamation of their drainage areas is completed or nearly complete and the outlets are no longer regulated by an NPDES permit or they have programmatically progressed to the point where NPDES permit limits for TMDL endpoints of metals such as total iron, total aluminum, or manganese have been removed from the permit (WVDEP, 2000). There are 2205 reclamation model inputs in the watershed (Appendix F, Reclamation Outlets Tab) that represent loading from historically permitted sources.

Details for both active and reclaimed mining point sources are provided in **Appendix F** of the Technical Report. **Figure 5-1** illustrates the extent of the mining NPDES outlets in the watershed.

5.1.2 Non-mining Point Sources

WVDEP DWWM controls water quality impacts from non-mining activities with point source discharges through the issuance of NPDES permits. WVDEP's OWRNPDES GIS coverage was used to determine the locations of these sources, and detailed permit information was obtained from WVDEP's ERIS database. Sources may include the process wastewater discharges from water treatment plants and industrial manufacturing operations, and stormwater discharges associated with industrial activity. There are 2 industrial wastewater discharges under one permit in the watersheds of metals impaired streams in the Tug Fork River watershed.

In the Tug Fork River watershed, there are limited sewage treatment facilities existing in the watersheds of metals impaired streams. The NPDES permits for those facilities do not contain iron effluent limitations; were not considered to be substantive metals sources; and were not explicitly represented in the modeling. Existing discharges from such sources do not require wasteload allocations pursuant to the metals TMDLs. A list of such negligible sources appears in **Appendix F** of the Technical Report. Any metals loading associated with such sources is contained in the background loading and accounted for in model calibration.

There are 64 modeled non-mining NPDES permitted outlets (12 water treatment plants, 30 Multi Sector Stormwater general permit outlets for industrial discharges, 7 individual permit outlets, and 13 WV DOH stormwater discharges) in the watersheds containing or contributing to metals impaired streams, which are displayed in **Figure 5-1**. The assigned WLAs for all non-mining NPDES outlets allow for continued discharge under existing permit requirements, whether those are expressed in effluent limits or benchmark values. For non-construction stormwater permits, BMP based limits with benchmark values to monitor BMP effectiveness constitute acceptable implementation of the WLAs. A complete list of the permits and outlets is provided in **Appendix F** of the Technical Report.

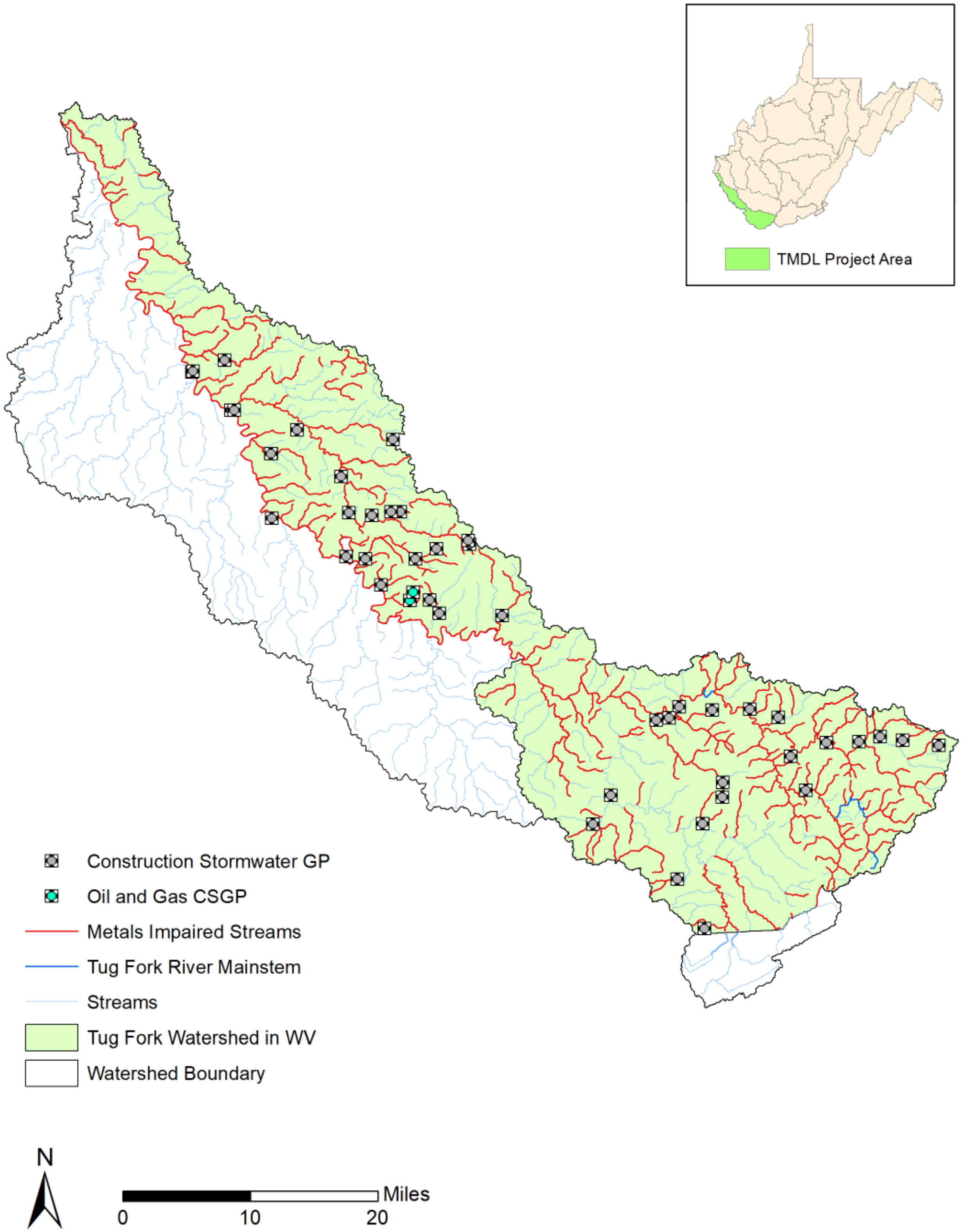
5.1.3 Construction Stormwater Permits

The discharges from construction activities that disturb more than one acre of land are legally defined as point sources and the sediment introduced from such discharges can contribute iron. WVDEP issues a General NPDES Permit (permit WV0115924, referred to as the Construction Stormwater General Permit or CSGP) to regulate stormwater discharges associated with construction activities with a land disturbance greater than one acre.

WVDEP also issues a General NPDES Permit to regulate the discharge of stormwater runoff associated with oil and gas related construction activities (permit WV0116815, referred to as the Oil and Gas Construction Stormwater General Permit or OGCSGP) authorizes discharges composed entirely of stormwater associated with oil and gas field activities or operations associated with exploration, production, processing or treatment operations or transmission facilities, disturbing one acre or greater of land area, to the waters of the State.

Both of these permits require that the site have properly installed best management practices (BMPs), such as silt fences, sediment traps, seeding/mulching, and riprap, to prevent or reduce erosion and sediment runoff. The BMPs will remain intact until the construction is complete and the site has been stabilized.

At the time of model set-up, 45 active construction sites with a total disturbed area of 421.74 acres registered under the CSGP were represented in the Tug Fork River watershed. Two registrations under the OGCSGP were represented in the model with a total disturbance of 68.38 acres. CSGP and OGCSGP registrations are shown in **Figure 5-2.** Specific WLAs are not prescribed for individual sites. Instead, subwatershed-based allocations are provided for concurrently disturbed area registered under the permits as described in **Sections 9.7.1** and **11.0**.



(Note: permits in close proximity appear to overlap in the figure)

Figure 5-2. Construction stormwater permits in the Tug Fork River watershed

5.1.4 Municipal Separate Storm Sewer Systems (MS4)

Runoff from residential and urbanized areas during storm events can be a significant sediment source. USEPA's stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from MS4s in specified urbanized areas. As such, their stormwater discharges are considered point sources and are prescribed WLAs. The MS4 entities are registered under the MS4 General Permit (WV0116025). There are no MS4 communities in the West Virginia portion of the Tug Fork River watershed.

5.2 Metals Nonpoint Sources

In addition to point sources, nonpoint sources can contribute to water quality impairments related to metals. For modeling purposes, land disturbing activities that introduce excess sediment are considered nonpoint sources of metals.

5.2.1 Abandoned Mine Lands

WVDEP's Office of Abandoned Mine Lands & Reclamation (AML&R) was created in 1981 to manage the reclamation of lands and waters affected by mining prior to passage of SMCRA in 1977. AML&R's mission is to protect public health, safety, and property from past coal mining and to enhance the environment through the reclamation and restoration of land and water resources. The AML program is funded by a fee placed on coal mining. Allocations from the AML fund are made to state and tribal agencies through the congressional budgetary process.

The Office of AML&R identified locations of AML in the Tug Fork River watershed from their records. In addition, source tracking efforts by WVDEP DWWM and AML&R identified additional AML sources (discharges, seeps, portals, and refuse piles). Field data, such as GPS locations, water samples, and flow measurements, were collected to represent these sources and characterize their impact on water quality. Based on this work, AML represent a significant source of metals in certain metals impaired streams for which TMDLs are presented. In TMDL watersheds with metals, aluminum, and pH impairments, a total of 62 seeps associated with legacy mine practices, 1,798.66 acres of AML highwall and 1,573.83 acres of AML area were incorporated into the TMDL model. **Figure 5-3** displays metals nonpoint AML sources represented in the metals model.

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as AML discharges are modeled as nonpoint sources. The decision to assign LAs to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, non-permitted point source discharges. Likewise, by establishing these TMDLs with these discharges treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.

5.2.2 Legacy Mine Sources

Legacy mines are mining areas permitted and released after 1977 when SMCRA took effect but continue to contribute background loading of metals.

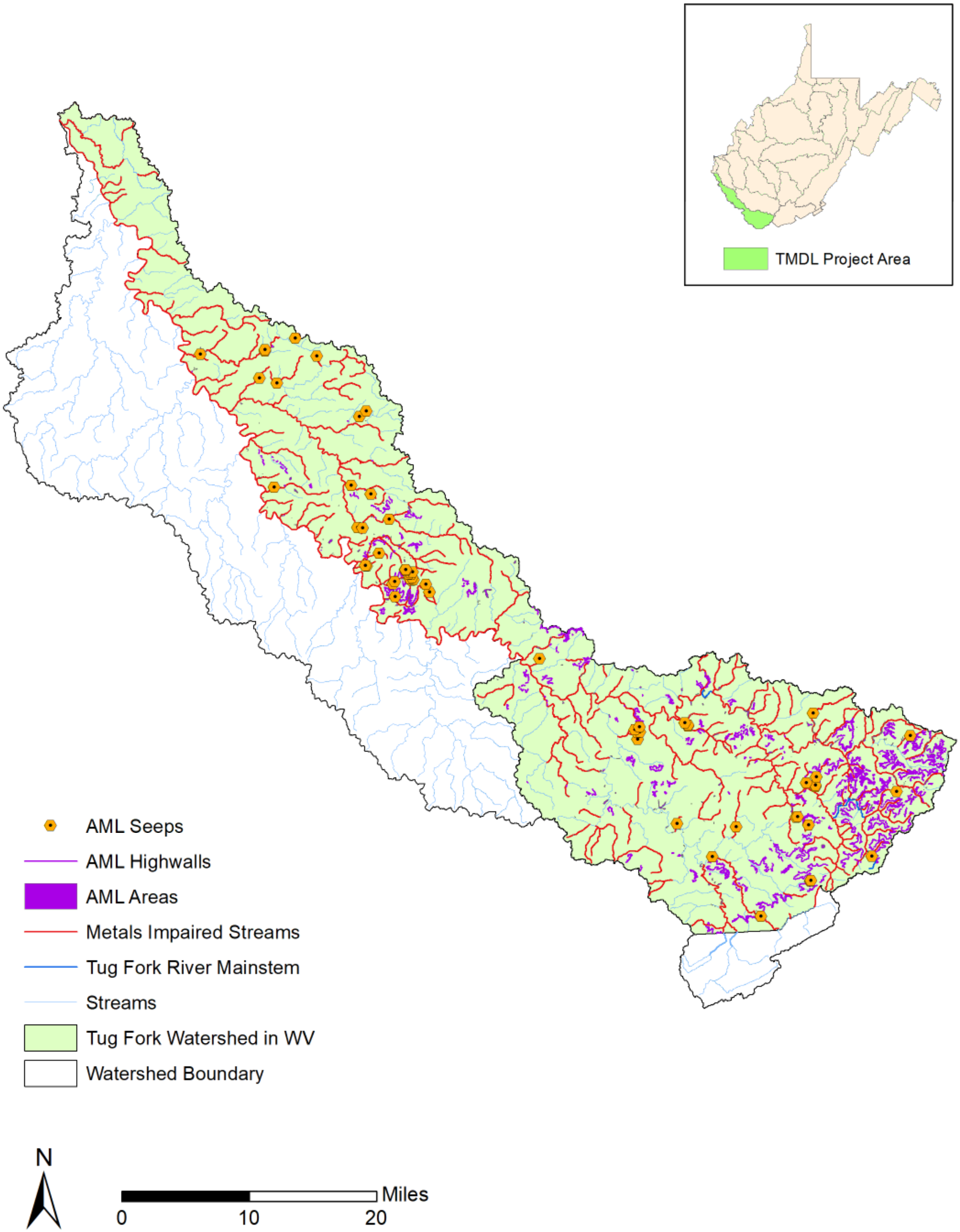


Figure 5-3. AML sources in the Tug Fork River watershed

Legacy mine areas without an active NPDES permit are treated as nonpoint source LAs for TMDL purposes. There are 17 nonpoint source legacy mine areas represented in the model similar to background for metals modeling.

5.2.3 Sediment Sources

Land disturbance can increase sediment loading to impaired waters. The control of sediment-producing sources has been determined to be necessary to meet water quality criteria for total iron during high-flow conditions. Nonpoint sources of sediment include forestry operations, oil and gas operations, roads, agriculture, stormwater from construction sites less than one acre, and stormwater from urban and residential land in non-MS4 areas. Additionally, streambank erosion represents a significant sediment source throughout the watershed. Upland sediment nonpoint sources are summarized below.

Forestry

West Virginia recognizes the water quality issues posed by sediment from logging sites. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act. The act requires the use of BMPs to reduce sediment loads to nearby waterbodies. Without properly installed BMPs, logging and associated access roads can increase sediment loading to streams. The West Virginia Bureau of Commerce’s Division of Forestry provided information on forest industry sites (registered logging sites) in the metals impaired TMDL watersheds. This information included the 16,681 acres of harvested area within the TMDL impaired streams watersheds, of which subset of land disturbed by roads and landings is 1,334 acres. According to the Division of Forestry, illicit logging operations represent approximately 2.5 percent of the total harvested forest area (registered logging sites) throughout West Virginia. This rate of illicit activity has been represented in the model. These illicit operations do not have properly installed BMPs and can contribute sediment to streams. In addition, 3,739 acres of burned forest were reported and included as disturbed land for calibration purposes only. **Figure 5-4** displays modeled metals nonpoint sources burned forest and logging operations in TMDL watersheds represented in the metals model.

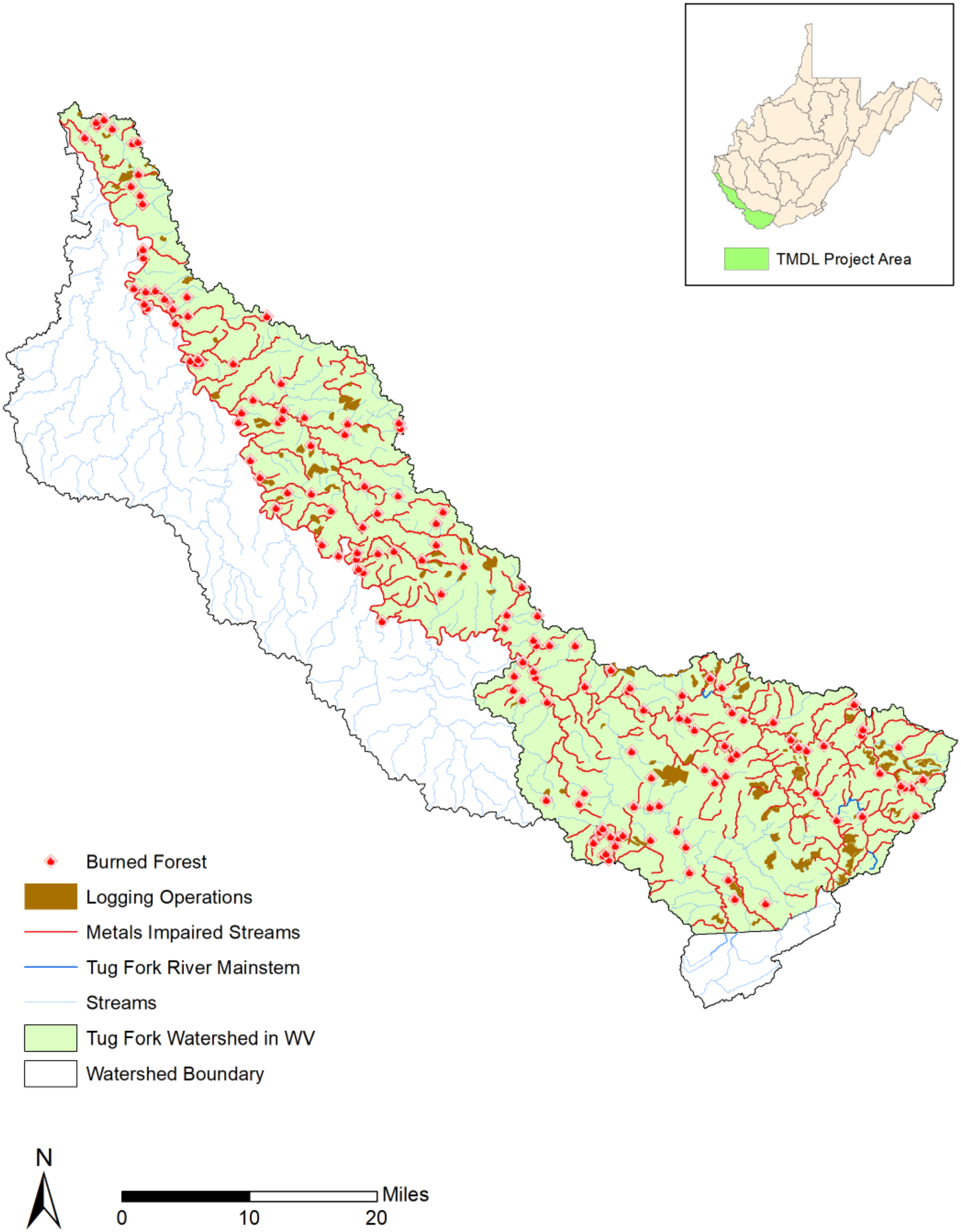


Figure 5-4. Forestry sources in the Tug Fork River watershed

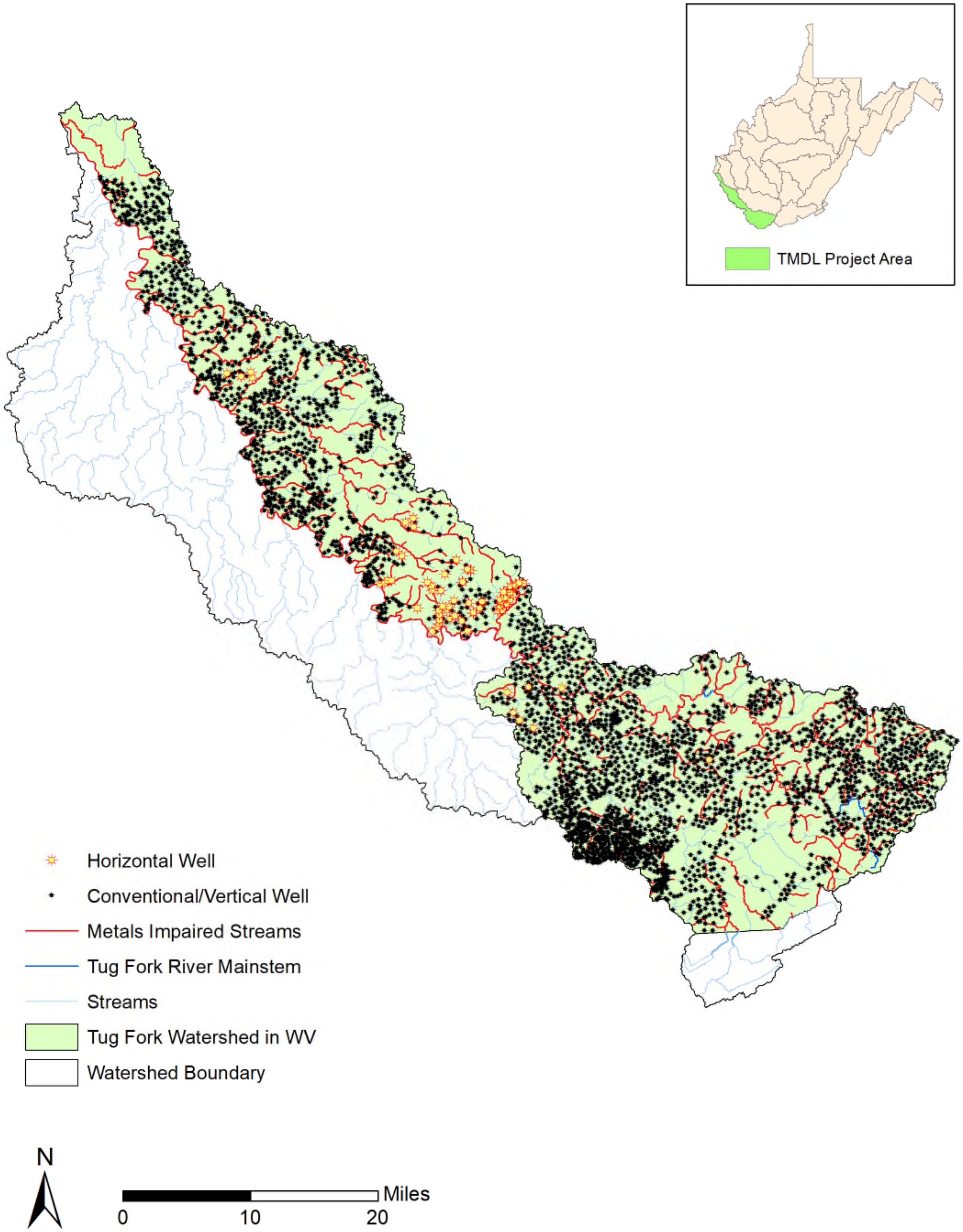
Oil and Gas

The WVDEP Office of Oil and Gas (OOG) is responsible for monitoring and regulating all actions related to the exploration, drilling, storage, and production of oil and natural gas in West Virginia. It maintains records on more than 55,000 active and 15,000 inactive oil and gas wells, and manages the Abandoned Well Plugging and Reclamation Program. The OOG also ensures that surface water and groundwater are protected from oil and gas activities.

Gas wells targeting the Marcellus Shale geologic formation use hydraulic fracturing techniques that result in significantly higher land disturbance than conventional wells. Horizontal Marcellus drilling sites typically require a flat “pad” area of several acres to hold equipment, access roads capable of supporting heavy vehicle traffic, and temporary ponds for storing water used during the drilling process. Vertical and horizontal Marcellus drilling site were identified and represented in the model, in addition to conventional wells.

Oil and gas data incorporated into the TMDL model were obtained from the WVDEP OOG GIS coverage. There are 1,941 active conventional and vertical oil and gas wells (represented as 7,992 acres), and 107 horizontal wells (represented as 244 acres) represented in the metals impaired TMDL watersheds addressed in this report. Runoff from unpaved access roads to these wells and the disturbed areas around the wells contribute sediment to adjacent streams (**Figure 5-5**).

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as oil and gas discharges are modeled as nonpoint sources. The decision to assign LAs to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, non-permitted point source discharges. Likewise, by establishing these TMDLs with these discharges treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.



(Note: wells in close proximity appear to overlap in the figure)

Figure 5-5. Oil and Gas Well locations in the Tug Fork River watershed

Roads

Heightened stormwater runoff from paved roads (impervious surface) can increase erosion potential. Unpaved roads can contribute sediment through precipitation-driven runoff. Roads that traverse stream paths elevate the potential for direct deposition of sediment. Road construction and repair can further increase sediment loads if BMPs are not properly employed.

Modeled paved roads acreages were developed from paved road data obtained from the U.S. Census Bureau's 2015 TIGER line shapefiles. Modeled unpaved roads acreages were estimated using a combination of several sources. Baseline unpaved roads acreages were extracted from 2015 TIGER roads data. TIGER road data has been observed to be incomplete in many West Virginia rural areas, therefore an effort was made to account for additional unpaved roads present in the watershed but not captured by TIGER.

Subwatersheds falling within the West Virginia portion of the Tug Fork watershed were analyzed using 2016 NAIP aerial photographs to digitize unpaved roads not captured by TIGER. A 12-foot width of the digitized unpaved roads was assumed. All West Virginia subwatersheds were analyzed for this effort. Kentucky and Virginia portions of the watershed were not analyzed. To avoid overestimating disturbance, only roads outside mine permit boundaries and known oil and gas development areas were digitized.

Some of the unpaved roads in the Tug Fork River watershed are recreational off-road vehicle trails. Many of these trails have been digitally mapped to facilitate use. West Virginia Trail Inventory GIS data is maintained by the West Virginia Department of Transportation (WVDOT 2019). Trail Inventory trails were assumed to be 12 feet wide for the purposes of calculating acreage. To avoid double counting unpaved roads in areas with significant recreational trail acreage, a formula was applied to calculate the final modeled unpaved road acreage. Where Trail Inventory unpaved roads exceeded 0.56 percent of the subwatershed, then the total modeled unpaved roads acreage equaled TIGER unpaved roads plus the Trail Inventory unpaved roads. If the Trail Inventory road acreage was less than 0.56 percent of the subwatershed (in many subwatersheds it was zero), then the total modeled unpaved roads acreage equaled the sum of the TIGER unpaved roads plus the additional unpaved road acreage estimate by subwatershed that was derived from digitizing unpaved roads from the aerial photos (0.56 percent).

Agriculture

Agricultural landuses account for roughly 0.1 percent of the modeled land area in the watershed. Although agricultural activity accounts for a small percentage of the overall watershed, agriculture is a significant localized nonpoint source of iron and sediment. Upland loading representation was based on precipitation and runoff, in which accumulation rates were developed using source tracking information regarding number of livestock, proximity and access to streams, and overall runoff potential. Sedimentation/iron impacts from agricultural landuses are also indirectly reflected in the streambank erosion allocations when considering vegetative cover.

Streambank Erosion

Streambank erosion has been determined to be a significant sediment source across the watershed. In past TMDL projects, WVDEP conducted a series of special bank erosion pin studies (WVDEP, 2012) which, combined with soils data and vegetative cover assessments, formed the foundation for representation of the baseline streambank sediment and iron loadings. Modeled sediment contributions from streambank erosion were increased on a case-by-case basis if a localized streambank disturbance with the potential to significantly affect in-stream sediment concentration was observed in a TMDL watershed. The sediment loading from bank erosion is considered a nonpoint source and LAs are assigned for stream segments.

Other Land-Disturbance Activities

Stormwater runoff from residential and urban landuses in non-MS4 areas is a significant source of sediment in parts of the watershed. Outside urbanized area boundaries, these landuses are considered to be nonpoint sources and load allocations are prescribed. The modified NLCD 2016 landuse data were used to determine the extent of residential and urban areas not subject to MS4 permitting requirements and source representation was based upon precipitation and runoff.

The NLCD 2016 landuse data also classifies certain areas as “barren” land. In the model configuration process, portions of the barren landuse were reclassified to account for other known sources. The remainder is represented as a specific nonpoint source category in the model.

Construction activities disturbing less than one acre are not subject to construction stormwater permitting. While not specifically represented in the model, their impact is indirectly accounted for in the loading rates established for the urban/residential landuse category.

6.0 pH SOURCE ASSESSMENT

pH impairments in the study area were caused by acidity introduced by historical mining activities and atmospheric acid deposition in the Tug Fork River watershed. WVDEP source tracking and pre-TMDL water quality monitoring observations were used to characterize the causative sources. Acid precipitation and the low buffering capacity of certain watersheds can contribute to lower observed pH. Atmospheric acid deposition was represented in the model at background levels, but it was not found to be the causative source for pH impaired streams in the Tug Fork River watershed. Active mining permits were also present in pH impaired stream watersheds but were not found to be a causative source of pH impairment.

6.1 Abandoned Mine Land Seeps

Discharges from historical mining activities can cause low pH impairments, iron and/or aluminum impairments. Because of the complex chemical interactions that occur between dissolved metals and acidity, the TMDL approach focused on reducing metals concentrations to meet metals and associated pH water quality criteria while accounting for watershed dynamics associated with buffering capacity. The AML sources in (Thacker Creek, UNT/Mile Branch RM 0.98, UNT/UNT RM 0.34/Mile Branch RM 0.98, and Mohawk Branch) were prescribed metals reductions in the TMDL allocation scenario to allow the stream to meet water quality standards.

6.2 Acid Deposition

Acid rain is produced when atmospheric moisture reacts with gases to form sulfuric acid, nitric acid, and carbonic acid. These gases are primarily formed from nitrogen dioxides and sulfur dioxide, which enter the atmosphere through exhaust and smoke from burning fossil fuels such as gas, oil, and coal. Two-thirds of sulfur dioxides and one-fourth of nitrogen oxides present in the atmosphere are attributed to fossil fuel burning electric power generating plants (USEPA, 2005). Acid rain crosses watershed boundaries and may originate in the Ohio River Valley or the Midwestern United States.

The majority of the acid deposition occurs in the eastern United States. In March 2005, the USEPA issued the Clean Air Interstate Rule (CAIR), which places caps on emissions for sulfur dioxide and nitrogen dioxides for the eastern United States. It was expected that CAIR would reduce sulfur dioxide emissions by over 70 percent and nitrogen oxides emissions by over 60 percent from the 2003 emission levels (USEPA, 2005).

Effective January 1, 2015, CAIR was replaced by the Cross-State Air Pollution Rule (CSAPR). Similar to CAIR, CSAPR also places caps on emissions for sulfur dioxide and nitrogen oxides for the eastern United States. Combined with other final state and EPA actions, CSAPR will reduce power plant SO_2 emissions by 73 percent and NO_X emissions by 54 percent from 2005 levels in the CSAPR region (USEPA, 2016).

On October 15, 2020, EPA proposed the Revised Cross-State Air Pollution Rule Update in order to fully address 21 states' outstanding interstate pollution transport obligations for the 2008 ozone National Ambient Air Quality Standards (NAAQS). Starting in the 2021 ozone season, the proposed rule would require additional emissions reductions of nitrogen oxides (NOx) from power plants in 12 states, including West Virginia (USEPA, 2021). Because pollution is highly mobile in the atmosphere, reductions based on the Revised CSAPR Update in West Virginia, Ohio, and Pennsylvania will likely improve the quality of precipitation in the watershed.

Acid deposition occurs by two main methods: wet and dry. Wet deposition occurs through rain, fog, and snow. Dry deposition originates from gases and particles. Dry deposition accounts for approximately half of the atmospheric deposition of acidity (USEPA, 2005). Winds blow the particles and gases contributing to acid deposition over large distances, including political boundaries, such as state boundaries. After dry deposition occurs, particles and gases can be washed into streams from trees, roofs, and other surfaces by precipitation.

Weekly wet deposition data were retrieved from National Atmospheric Deposition Program station WV04-Babcock State Park in Fayette County from 2000 to the most recent data 2014. The Clean Air Status and Trends Network (CASTNET) was accessed to retrieve dry deposition data from CDR119 in Gilmer County.

6.3 pH – Natural Alkalinity Sources

Soils with moderate buffering capacity such as skeletal loamy residuum weathered from sandstone and shale, as well as colluvium derived from sandstone and siltstone, could be a source of alkalinity in some modeled subwatersheds. Dissolution of carbonate rocks neutralizes the excessive acidity from atmospheric precipitation and provides natural loading of alkalinity to the streams. As a result, alkaline conditions are commonly, but not exclusively, observed in the streams from geologic formations present in the Tug Fork River Watershed.

Parameters such as base saturation, cation exchange capacity, dissolution susceptibility of aluminum minerals (aluminum hydroxides), and soil CO_2 control acidification of soils and the land outflows. The heterogeneous nature of these parameters results in different buffering capacities for different soil types. Thus, different soil types in subwatersheds were assumed to react differently to the acidity from atmospheric deposition.

7.0 FECAL COLIFORM SOURCE ASSESSMENT

7.1 Fecal Coliform Point Sources

Publicly and privately owned sewage treatment facilities and home aeration units are point sources of fecal coliform bacteria. The following sections discuss the specific types of fecal coliform point sources that were identified in the Tug Fork River watershed.

7.1.1 Individual NPDES Permits

WVDEP issues individual NPDES permits to both publicly owned and privately owned wastewater treatment facilities. Publicly owned treatment works (POTWs) are relatively large sewage treatment facilities with extensive wastewater collection systems, whereas private facilities are usually used in smaller applications such as subdivisions and shopping centers. Additionally specific discharges from industrial facilities are regulated for fecal coliform bacteria.

In the subject watersheds of this report, 10 individually permitted POTWs discharge treated effluent at 14 outlets. POTWs include: City of Gary, City of War, City of Welch, City of Williamson, Coalwood WWTP, Mingo County PSD, Town of Delbarton, Town of Iaeger, Town of Kermit, and Town of Matewan.

Seven mining bathhouse permits discharge in the Tug Fork River TMDL watersheds via 8 outlets. One private facility (Iaeger Elementary School) discharges through one outlet to Dry Fork (WV-BST-98). One Department of Highways Headquarters discharges through one industrial outlet to the Tug Fork mainstem (WV-BST) in McDowell County.

These sources are regulated by NPDES permits that require effluent disinfection and compliance with strict fecal coliform effluent limitations (200 counts/100 mL [geometric mean monthly] and 400 counts/100 mL [maximum daily]). Compliant facilities do not cause fecal coliform bacteria impairments because effluent limitations are more stringent than water quality criteria. Refer to the Technical Report **Appendix F** for details regarding NPDES permits.

7.1.2 Overflows

Combined sewer overflows (CSOs) are outfalls from POTW sewer systems that discharge untreated domestic waste and surface runoff. CSOs are permitted to discharge only during precipitation events. Sanitary sewer overflows (SSOs) are unpermitted overflows that occur as a result of excess inflow and/or infiltration to POTW separate sanitary collection systems. Both types of overflows contain fecal coliform bacteria.

In the subject watersheds, there were a total of 2 CSO outlets associated with the POTW collection system operated by the City of Welch. CSOs discharge to the Tug Fork River mainstem downstream of its confluence with Elkhorn Creek. No significant SSO discharges were represented in the model.

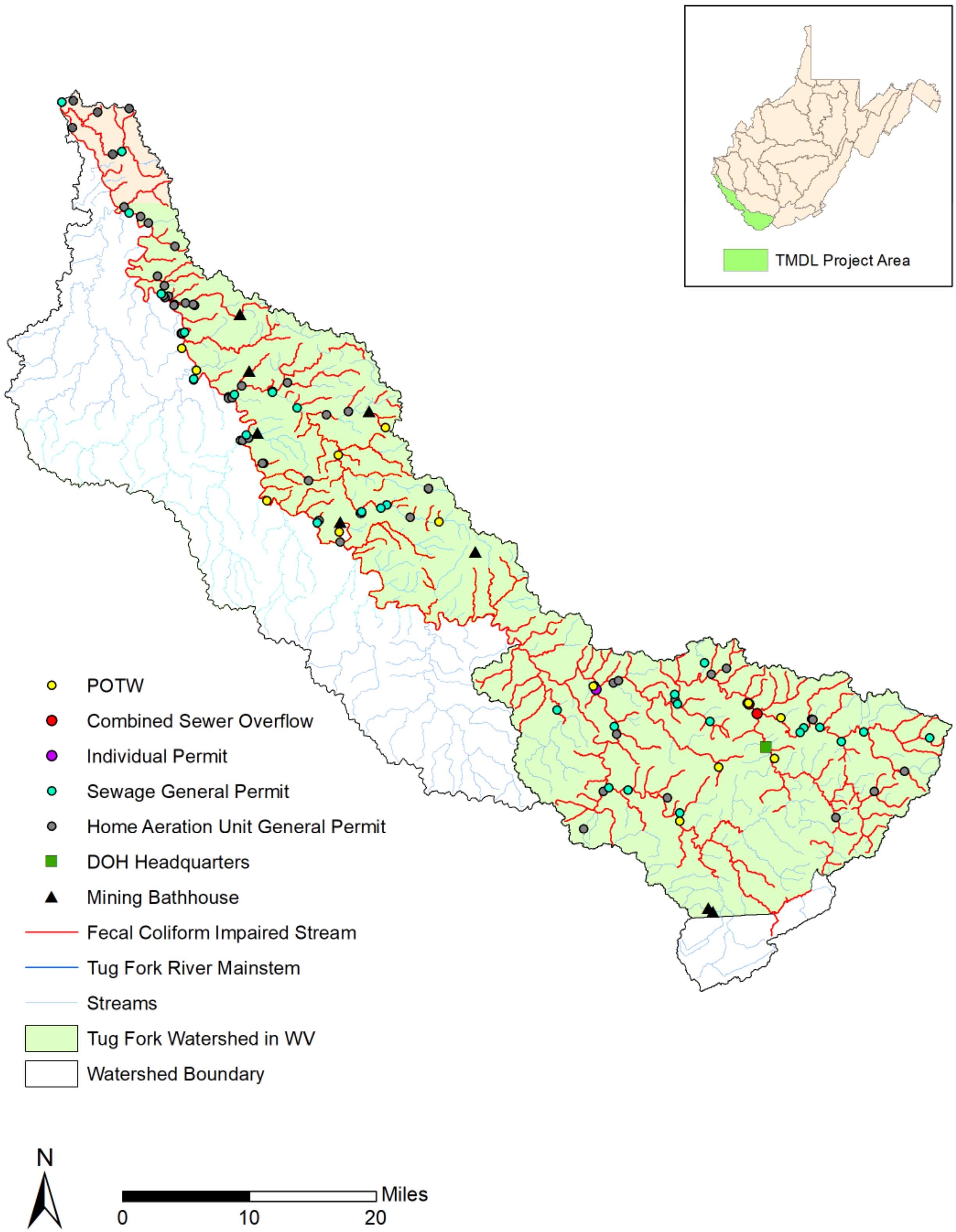
7.1.3 Municipal Separate Storm Sewer Systems (MS4)

Runoff from residential and urbanized areas during storm events can be a significant fecal coliform source. USEPA’s stormwater permitting regulations require public entities to obtain NPDES permit coverage for stormwater discharges from MS4s in specified urbanized areas. As such, MS4 stormwater discharges are considered point sources and are prescribed WLAs.

There are no MS4 communities in the Tug Fork River watershed.

7.1.4 General Sewage Permits

General sewage permits are designed to cover a class of facilities with similar type discharges from numerous individual owners and facilities throughout the state under one permit. General Permit WV0103110 regulates small, privately owned sewage treatment plants (“package plants”) that have a design flow of 50,000 gallons per day (gpd) or less. General Permit WV0107000 regulates home aeration units (HAUs). HAUs are small sewage treatment plants primarily used by individual residences where site considerations preclude typical septic tank and leach field installation. Both general permits contain fecal coliform effluent limitations identical to those in individual NPDES permits for sewage treatment facilities. In the areas draining to streams for which fecal coliform TMDLs have been developed, 32 facilities are registered under the “package plant” general permit, and 64 are registered under the HAU general permit. Modeled point source locations are shown on **Figure 7-1.**



(Note: outlets in close proximity appear to overlap in the figure)

Figure 7-1. Fecal coliform point sources

7.2 Fecal Coliform Nonpoint Sources

7.2.1 On-site Treatment Systems

Failing septic systems and straight pipes are significant nonpoint sources of fecal coliform bacteria in the Tug Fork River watershed. Because abandoned homes are common in the watershed, WVDEP personnel performed field surveys to obtain estimates of the percentage of all structures that were occupied homes. During this effort, 109 subwatersheds were surveyed for percent occupied structures. Surveyed subwatersheds were classified into three development categories: Rural Residential, Moderately Developed Rural, and Densely Developed. Each development category was assigned an average percent occupied value derived from field observations: Rural Residential (47 percent), Moderately Developed Rural (60 percent), and Densely Developed (60 percent). GIS resources and aerial photographs were used to classify the remaining subwatersheds not visited during field surveys. The field observed and GIS classified occupation percentages were multiplied by the number of structures in each subwatershed known from 911 emergency GIS data to calculate the total number of homes with potentially failing septic systems.

Information collected during source tracking efforts by WVDEP yielded an estimate of 13,500 homes that are not served by centralized sewage collection and treatment systems and are within 100 meters of a stream. Homes located more than 100 meters from a stream were not considered significant potential sources of fecal coliform because of the natural attenuation of fecal coliform concentrations that occurs because of bacterial die-off during overland travel (Walsh and Kunapo, 2009). Estimated septic system failure rates across the watershed range from 3 percent to 28 percent. Section 3.1.4 of the Technical Report describes the methods used to characterize failing septic systems.

Due to a wide range of available literature values relating to the bacteria loading associated with failing septic systems, a customized Microsoft Excel spreadsheet tool was created to represent the fecal coliform bacteria contribution from failing on-site septic systems. WVDEP's pre-TMDL monitoring and source tracking data were used in the calculations. To calculate loads, values for both wastewater flow and fecal coliform concentration were needed.

To calculate failing septic wastewater flows, the TMDL watersheds were divided into three septic failure zones. During the WVDEP source tracking process, septic failure zones were delineated by soil characteristics (soil permeability, depth to bedrock, depth to groundwater and drainage capacity) as shown in United States Department of Agriculture (USDA) county soil survey maps. Two types of failure were considered, complete failure and periodic failure. For the purposes of this analysis, complete failure was defined as 50 gallons per house per day of untreated sewage escaping a septic system as overland flow to receiving waters and periodic failure was defined as 25 gallons per house per day. **Figure 7-2** shows the fecal coliform counts per year represented in the model from failing septic systems relative to the total stream length in meters for each subwatershed.

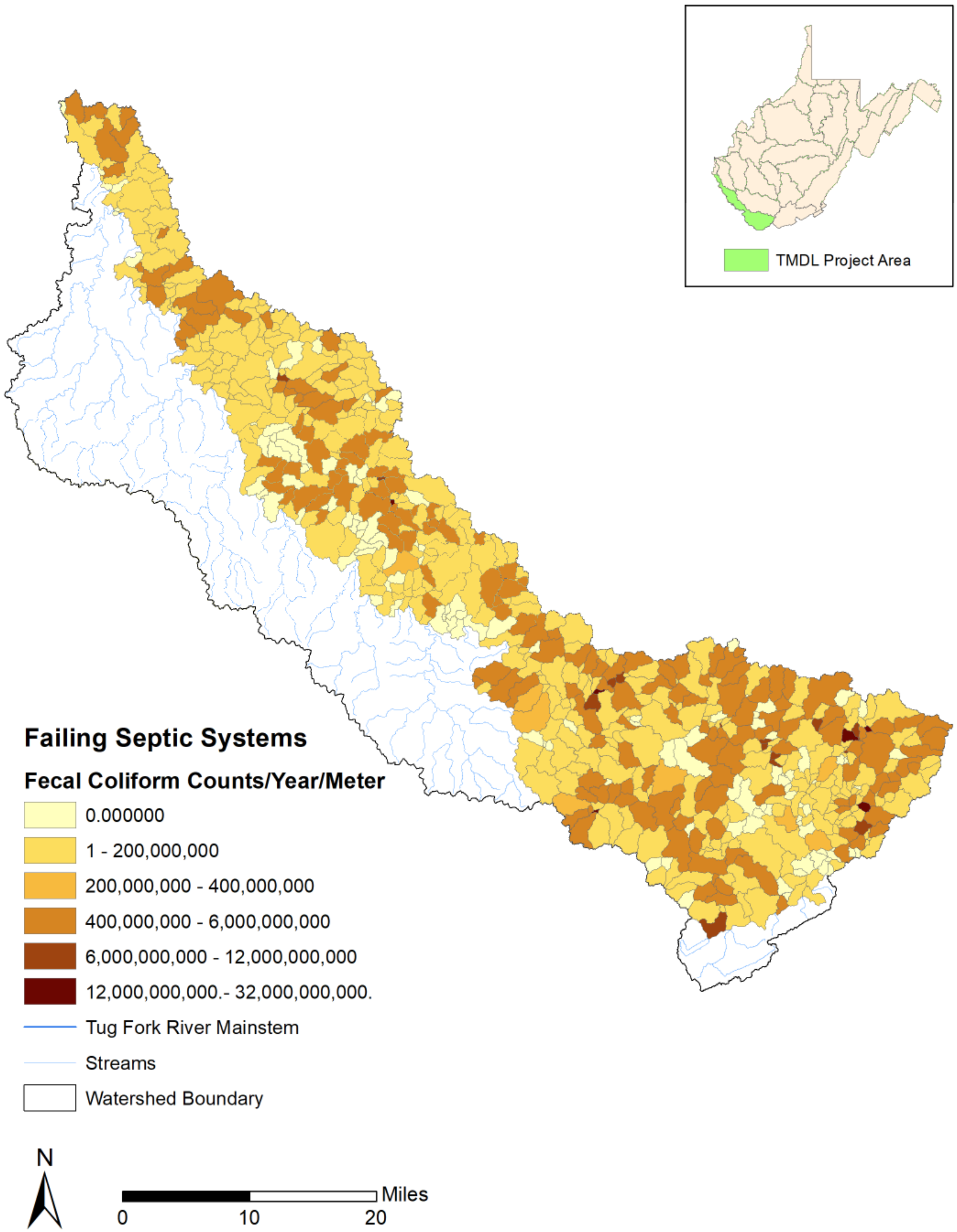


Figure 7-2. Fecal coliform counts attributed to failing septic systems per year relative to the stream lengths (meters) in each subwatershed in the Tug Fork River watershed as represented in modeling.

Once failing septic flows were modeled, a fecal coliform concentration was determined at the TMDL watershed scale. Based on past experience with other West Virginia TMDLs, a base concentration of 10,000 counts per 100 ml was used as a beginning concentration for failing septic systems, and was further refined during model calibration. A sensitivity analysis was performed by varying the modeled failing septic concentrations in multiple model runs, and then comparing model output to pre-TMDL monitoring data.

For the purposes of this TMDL, discharges from activities that do not have an associated NPDES permit, such as failing septic systems and straight pipes, are considered nonpoint sources. The decision to assign LAs to those sources does not reflect a determination by WVDEP or USEPA as to whether they are, in fact, non-permitted point source discharges. Likewise, by establishing these TMDLs with failing septic systems and straight pipes treated as nonpoint sources, WVDEP and USEPA are not determining that such discharges are exempt from NPDES permitting requirements.

7.2.2 Urban/Residential Runoff

Stormwater runoff from residential and urbanized areas that are not subject to MS4 permitting requirements can be a significant source of fecal coliform bacteria. These landuses are considered to be nonpoint sources and load allocations are prescribed. The modified NLCD 2016 landuse data were used to determine the extent of residential and urban areas not subject to MS4 permitting requirements and source representation was based upon precipitation and runoff.

7.2.3 Agriculture

Agricultural activities can contribute fecal coliform bacteria to receiving streams through surface runoff or direct deposition. Grazing livestock and land application of manure result in the deposition and accumulation of bacteria on land surfaces. These bacteria are then available for wash-off and transport during rain events. In addition, livestock with unrestricted access can deposit feces directly into streams.

Although agricultural activity accounts for a small percentage of the overall watershed, agriculture is a significant localized nonpoint source of fecal coliform bacteria. Source tracking efforts identified pastures and feedlots near impaired segments that have localized impacts on instream bacteria levels. Source representation was based upon precipitation and runoff, and source tracking information regarding number of livestock, proximity and access to stream, and overall runoff potential were used to develop accumulation rates.

7.2.4 Natural Background (Wildlife)

A certain “natural background” contribution of fecal coliform bacteria can be attributed to deposition by wildlife in forested areas. Accumulation rates for fecal coliform bacteria in forested areas were developed using reference numbers from past TMDLs, which incorporated wildlife estimates obtained from West Virginia’s Division of Natural Resources (WVDNR). In addition, WVDEP conducted storm-sampling on a 100 percent forested subwatershed (Shrewsbury Hollow) within the Kanawha State Forest, Kanawha County, West Virginia to determine wildlife contributions of fecal coliform and these results were used during the model calibration process. On the basis of the low fecal accumulation rates for forested areas, the storm water sampling results, and model simulations, wildlife is not considered to be a significant nonpoint source of fecal coliform bacteria in the watershed.

8.0 DISSOLVED OXYGEN SOURCE ASSESSMENT

As noted in the **Executive Summary**, there is one stream, Little Slate Creek (WV-BST-98-Z_03), impaired for dissolved oxygen and fecal coliform bacteria, both commonly associated with organic enrichment. Excessive amounts of organic matter increase fecal coliform bacteria counts and reduce dissolved oxygen levels. Generally, point and non-point sources contributing to dissolved oxygen impairments are the same as those for fecal coliform.

Two DO violations occurred in Little Slate Creek in August 2018 and July 2019. Violations were observed at a pre-TMDL water quality monitoring station near the mouth at river mile 0.1. Other monitoring stations in Little State Creek above the station with low DO observations did not record violations. The WVDEP pre-TMDL monitoring site disturbance notes list the presence of raw sewage, algae and organic material growing on sediment substrate, an underground sulfur “spring” discharge accompanied by sulfur odor, as well as aluminum and manganese precipitates in the stream. There are no agricultural sources of nutrients or organic material in Little Slate Creek.

Organic loading associated with untreated sewage discharges would be the expected cause of DO violations in Little Slate Creek. Failing septic systems with straight pipes contribute bacterial loading that would reduce the assimilative capacity of the stream during periods of low flow. For a discussion of best management practices (BMP) pollutant reduction efficiencies see Section 8 of the TMDL Technical Report. Implementation of the fecal coliform TMDL for Little Slate Creek will reduce the organic loads and will resolve the dissolved oxygen impairment in the stream.

9.0 MODELING PROCESS

Establishing the relationship between the instream water quality targets and source loadings is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses with flow and loading conditions. This section presents the approach taken to develop the linkage between sources and instream response for TMDL development in the Tug Fork River watershed.

9.1 Model Selection

Selection of the appropriate analytical technique for TMDL development was based on an evaluation of technical and regulatory criteria. The following key technical factors were considered in the selection process:

- Scale of analysis
- Point and nonpoint sources
- Metals and fecal coliform bacteria impairments are temporally variable and occur at low, average, and high flow conditions
- Total iron loadings and instream concentrations are related to sediment
- Time-variable aspects of land practices have a large effect on instream pollutant concentrations
- Pollutant transport mechanisms are variable and often weather-dependent

The primary regulatory factor that influenced the selection process was West Virginia's water quality criteria. According to 40 CFR Part 130, TMDLs must be designed to implement applicable water quality standards. The applicable water quality criteria for iron, aluminum, pH, and fecal coliform bacteria in West Virginia are presented in **Section 2.2**, **Table 2-1**. West Virginia numeric water quality criteria are applicable at all stream flows greater than the 7-day, 10-year low flow (7Q10). The approach or modeling technique must permit representation of instream concentrations under a variety of flow conditions to evaluate critical flow periods for comparison with criteria.

The TMDL development approach must also consider the dominant processes affecting pollutant loadings and instream fate. In the Tug Fork River watershed, an array of point and nonpoint sources contributes to the various impairments. Most nonpoint sources are rainfall-driven with pollutant loadings primarily related to surface runoff, but some, such as inadequate onsite residential sewage treatment systems, function as continuous discharges. Similarly, certain point sources are precipitation-induced while others are continuous discharges. While loading function variations must be recognized in the representation of the various sources, the TMDL allocation process must prescribe WLAs for all contributing point sources and LAs for all contributing nonpoint sources.

The MDAS was developed specifically for TMDL application in West Virginia to facilitate large scale, data intensive watershed modeling applications. The MDAS is a system designed to support TMDL development for areas affected by nonpoint and point sources. The MDAS component most critical to TMDL development is the dynamic watershed model because it provides the linkage between source contributions and instream response. The MDAS is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and instream water quality. It is capable of simulating different flow regimes and pollutant loading variations. A key advantage of the MDAS' development framework is that it has no inherent limitations in terms of modeling size or upper limit of model operations. In addition, the MDAS model allows for seamless integration with modern-day, widely available software such as Microsoft Access and Excel. Sediment, total iron, aluminum, pH, manganese, and fecal coliform bacteria were modeled using the MDAS.

9.2 Model Setup

Model setup consisted of configuring the following four separate MDAS models: iron/sediment; aluminum/pH/manganese, and fecal coliform bacteria.

9.2.1 General MDAS Configuration

Configuration of the MDAS model involved subdividing the TMDL watersheds into subwatershed modeling units connected by stream reaches. Physical characteristics of the subwatersheds - weather data, landuse information, continuous discharges, and stream data - were used as inputs. Flow and water quality were continuously simulated on an hourly time-step.

Two grid-based weather data products were used to develop MDAS model weather input files for TMDL modeling. The Parameter-Elevation Regressions on Independent Slopes Model (PRISM) and the North American Land Data Assimilation System (NLDAS-2) are both publicly available weather datasets. PRISM data features daily weather on 4 km grid spatial scale, and NLDAS-2 data has hourly weather on a 12 km grid scale. Both datasets combine rain gauge data with radar observations to predict hourly weather parameters such as precipitation, solar radiation, wind, and humidity. For more information on PRISM and NLDAS-2, refer to Section 2 of the Technical Report.

PRISM daily weather data and NLDAS-2 hourly precipitation data were obtained and processed to create a time series for each PRISM grid cell that contained modeled TMDL watersheds. Using the precipitation and temperature time series, a model weather input file was developed for each PRISM grid cell. Given that only slight variability was observed between the grid cells at the 12-digit Hydrologic Unit Code (HUC) scale, and to allow for faster model run times, twelve weather input files in the Tug Fork River watershed were developed by taking an area-weighted average of PRISM values and applying them to a grouping of several adjacent 12-digit HUC areas. Model subwatersheds falling within each 12-digit HUC grouping were then assigned the appropriate weather input file for hydrologic modeling purposes.

The 88 West Virginia TMDL watersheds plus out of state areas draining to the Tug mainstem were broken into 838 separate subwatershed units, based on the groupings of impaired streams shown in **Figure 3-2**. The TMDL watersheds were divided to allow evaluation of water quality and flow at pre-TMDL monitoring stations. This subdivision process also ensures a proper stream network configuration within the basin.

9.2.2 Metals and Sediment Configuration

The modeled landuse categories contributing metals via precipitation and runoff include forest, pasture, cropland, wetlands, barren, residential/urban impervious, and residential/urban pervious.

These sources were represented explicitly by consolidating existing NLCD 2016 landuse categories to create modeled landuse groupings. Several additional landuse categories were created to account for landuses either not included in the NLCD 2016 and/or representing recent land disturbance activities (e.g., harvested forest and skid roads, oil and gas operations, paved and unpaved roads). The process of consolidating and updating the modeled landuses is explained in further detail in the Technical Report. Non-sediment related iron land-based sources were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget.

Traditional point sources (e.g., industrial discharges) were modeled as direct, continuous-flow sources in the model, with the baseline flow and pollutant characteristics obtained from permitting databases.

Sediment-producing landuses and bank erosion are sources of iron because the relatively high iron content of the soils in the watershed. Statistical analyses using pre-TMDL monitoring data collected in the TMDL watersheds were performed to establish the correlation between instream sediment and iron metals concentrations. The results were then applied to the sediment from sediment-producing landuses and streambank erosion to calculate the iron loads delivered to the streams.

Generation of upland sediment loads depends on the intensity of surface runoff and varies by landuse and the characteristics of the soil. Soil erodibility and sediment washoff coefficients varied among soil types and landuses and were used to simulate sediment erosion by surface runoff. Sediment delivery paths modeled were surface runoff erosion and streambank erosion. Streambank erosion was modeled as a unique sediment source, independent of other upland-associated erosion sources.

The MDAS bank erosion model takes into account stream flow and bank stability using the following methodology. Each stream segment has a flow threshold (Q Threshold) above which streambank erosion occurs. This threshold is estimated as the flow that occurs at bank full depth. The bank erosion rate per unit area is a function of bank flow volume above the specified threshold and the bank erodible area (Q Bank Erosion). The bank scouring process is a power function dependent upon high-flow events exceeding the flow threshold. Bank erosion rates increase when the flow is above the Q Threshold.

The wetted perimeter and reach length represent ground area covered by water (**Figure 9-1**). The erodible wetted perimeter is equal to the difference between the actual wetted perimeter and wetted perimeter during threshold flow conditions. The bank erosion rate per unit area was multiplied by the erodible perimeter and the reach length to obtain an estimate of eroded sediment mass corresponding to the stream segment.

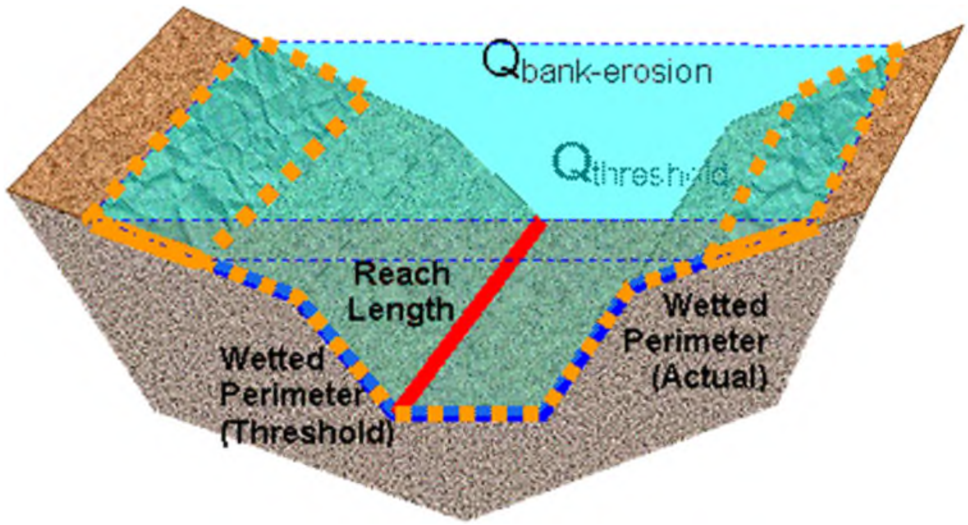


Figure 9-1. Conceptual diagram of stream channel components used in the bank erosion model

Another important variable in the prediction of sediment yield is bank stability as defined by coefficient for scour of the bank matrix soil (referred to as "kber") for the reach. Both quantitative and qualitative assessments indicated that vegetative cover was the most important factor controlling bank stability. Overall bank stability was initially characterized by assessing and rating bank vegetative cover from aerial photography on a subwatershed basis. The erodibility coefficient from soils data was used to refine this assessment. Using the aerial assessment and the soil erodibility data together, the subwatershed's bank condition was scored and each level was associated with a kber value. Streambank erosion soil loss results from the model were compared to field data available from previous WVDEP streambank erosion pin studies to verify that the amount of lost sediment generated by the model was within reason.

The Technical Report provides more detailed discussions on the technical approaches used for streambank erosion and sediment modeling.

9.2.3 Aluminum, Manganese and pH Configuration

The MDAS model includes a dynamic chemical species fate and transport module that simulates soil subsurface and in-stream water quality taking into account chemical species interaction and transformation. The time series for total chemical concentration and flows generated by MDAS are used as inputs for the modules' pollutant transformation and transport routines. The modules simulate soil subsurface and in-stream chemical reactions, assuming instant mixing and concentrations equally distributed throughout soil and stream segments. The model supports major chemical reactions, including acid/base, complexation, precipitation, and dissolution reactions and some kinetic reactions. The model selection process, modeling methodologies, and technical approaches are discussed further in the Technical Report.

Pollutant Source Configuration

Legacy mining discharges generate metal and acidity loadings. These sources were identified and sampled for pH, cations and anions including targeted metals during source tracking. Flow rates from these sources were measured simultaneously. The model incorporates these stationary sources as direct, continuous-flow sources based on the observed data. Due to the potential time variable nature of the sources, the constant loadings were adjusted during the model calibration using the instream water quality data.

Active mining permits discharge metals loadings and are subject to meeting effluent concentrations prescribed by their permit limits. The model incorporated active mining permitted outlets either as precipitation induced land-based sources or continuous flow sources depending on their outlet specifications.

Precipitation induced of total aluminum and total iron were modeled using representative average concentrations for the surface, interflow and groundwater portions of the water budget. The contributions of acidity and species that impact the calculation of alkalinity and pH were represented in the land-based loadings in the model.

In order to represent the effects of acid precipitation, soil type parameters were selected using the literature and refined based on site data ranges. The concentrations of the wet deposition data were assigned to rainfall events. The dry deposition was assumed to accumulate daily and wash off during the precipitation events and was assumed to be included implicitly in the loads being generated at the surface. Clean Air Status and Trends Network (CASTNET) was accessed to retrieve the dry deposition data. Adjustment and verification of these parameters occurred by examining water quality data in streams where watersheds did not include legacy mine discharges or alkalinity mitigation. This aspect of the model provided the link between atmospheric deposition and soil buffering capacity.

Instream Chemical Reaction

All the loadings from the previously described upland loading sources were discharged to the stream via the hydrologic functionalities of the model. All added loadings were subjected to subsequent instream chemical reactions. The important reactions identified to control instream pH and dissolved aluminum are:

- Mineral precipitation
- Stream travel time relative to reaction time
- Stream buffering capacity
- Sediment deposition rates in relation to stream velocity

During the model calibration, it was identified that the instream dissolved aluminum/pH conditions were mostly influenced by mineral precipitation. Precipitation and deposition were more likely to occur during low flow conditions when more time was available for chemical reactions. The model indicated that the available buffering capacity of the stream to counteract hydrogen acidity from the precipitation reaction was also important. Alkalinity dosing scenarios provided more buffering capacity. Buffering and dilution positively affected downstream concentrations.

9.2.4 Fecal Coliform Configuration

Modeled landuse categories contributing bacteria via precipitation and runoff include pasture, cropland, urban/residential pervious lands, urban/residential impervious lands, grassland, forest, barren land, and wetlands. Other sources, such as failing septic systems and discharges from sewage treatment facilities, were modeled as direct, continuous-flow sources in the model.

The basis for the initial bacteria loading rates for landuses and direct sources is described in the Technical Report. The initial estimates were further refined during the model calibration. A variety of modeling tools were used to develop the fecal coliform bacteria TMDLs, including the MDAS, and a customized spreadsheet to determine the fecal loading from failing residential septic systems identified during source tracking efforts by the WVDEP. **Section 7.2.1** describes the process of assigning flow and fecal coliform concentrations to failing septic systems.

9.3 Hydrology Calibration

Hydrology and water quality calibration were performed in sequence because water quality modeling is dependent on an accurate hydrology simulation. Typically, hydrology calibration involves a comparison of model results with instream flow observations from USGS flow gauging stations throughout the watershed. Five USGS gauging stations located in the Tug Fork River watershed had adequate recorded data for model hydrology calibration:

- USGS 03214500 Tug Fork at Kermit, WV
- USGS 03213700 Tug Fork at Williamson, WV
- USGS 03213500 Panther Creek Near Panther, WV
- USGS 03212980 Dry Fork at Beartown, WV
- USGS 03212750 Tug Fork Downstream of Elkhorn Creek at Welch, WV

Hydrology calibration compared observed data from the stations and modeled runoff from the landuses present in the watershed. Key considerations for hydrology calibration included the overall water balance, the high- and low-flow distribution, storm flows, and seasonal variation. The hydrology was validated for the time period of January 1, 2010 to December 31, 2019. As a starting point, many of the hydrology calibration parameters originated from the USGS Scientific Investigations Report 2005-5099 (Atkins, 2005). Final adjustments to model hydrology were based on flow measurements obtained during WVDEP's pre-TMDL monitoring in the Tug Fork River watershed. This same validation time period (2010 – 2019) was also used to develop average daily loads that form the LA, WLA, MOS, and TMDL components found in the TMDLs in **Section 10** of this report. A detailed description of the hydrology calibration and a summary of the results and validation are presented in the Technical Report in **Appendix I**.

9.4 Water Quality Calibration

After the model was configured and calibrated for hydrology, the next step was to perform water quality calibration for the subject pollutants. The goal of water quality calibration was to refine model parameter values to reflect the unique characteristics of the watershed so that model output would predict field conditions as closely as possible. Both spatial and temporal aspects were evaluated through the calibration process.

The water quality was calibrated by comparing modeled versus observed pollutant concentrations. The water quality calibration consisted of executing the MDAS model, comparing the model results to available observations, and adjusting water quality parameters within reasonable ranges. Initial model parameters for the various pollutant parameters were derived from previous West Virginia TMDL studies, storm sampling efforts, and literature values. Available monitoring data in the watershed were identified and assessed for application to calibration. Monitoring stations with observations that represented a range of hydrologic conditions, source types, and pollutants were selected. The time-period for water quality calibration was selected based on the availability of the observed data and their relevance to the current conditions in the watershed.

WVDEP also conducted storm monitoring on Shrewsbury Hollow in Kanawha State Forest, Kanawha County, West Virginia. The data gathered during this sampling episode was used in the calibration of fecal coliform and to enhance the representation of background conditions from undisturbed areas. The results of the storm sampling fecal coliform calibration are shown in **Figure 9-2**.

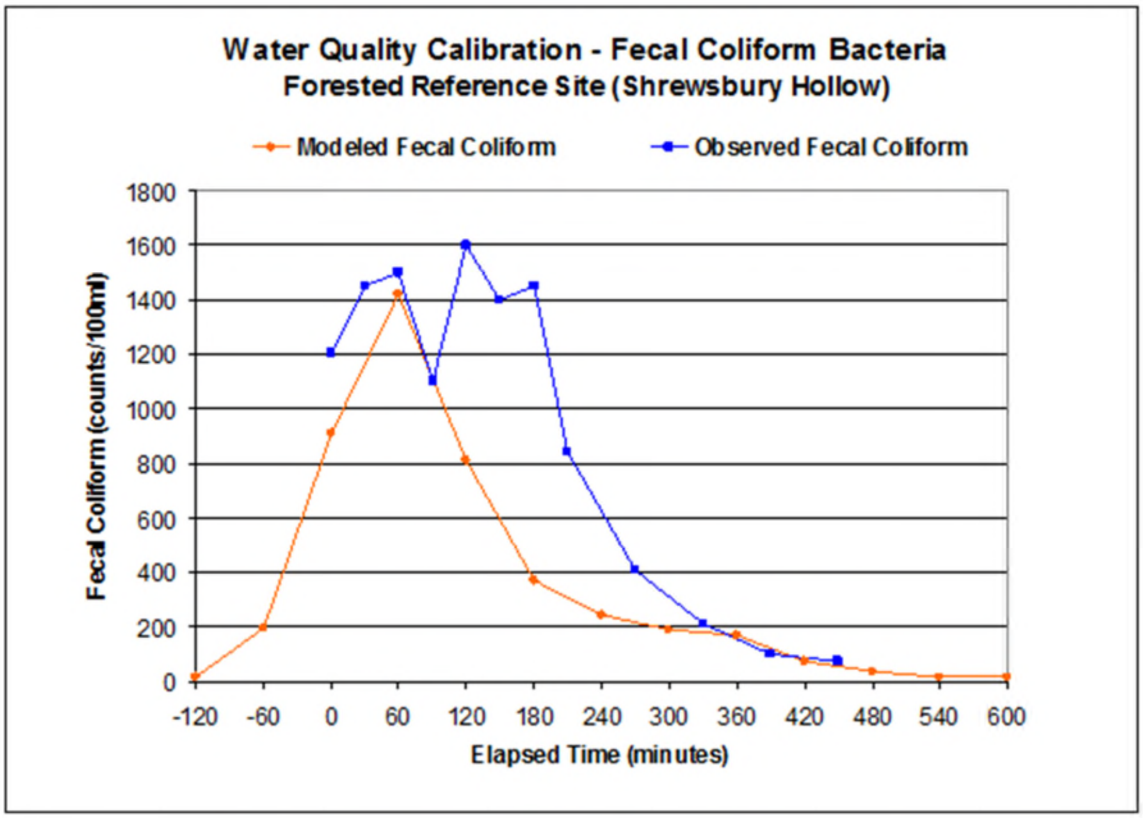


Figure 9-2. Shrewsbury Hollow fecal coliform observed data

Sediment calibration consisted of adjusting the soil erodibility and sediment transport parameters by landuse, and the coefficient of scour for bank-erosion. Initial values for these parameters were based on available landuse-specific storm-sampling monitoring data. Initial values were adjusted so that the model's suspended solids output closely matched observed instream data in watersheds with predominately one type of landuse.

9.5 Modeling Technique for Biological Impacts with Sedimentation Stressors

The SI process discussed in **Section 4** identified sedimentation as a significant biological stressor in some of the streams. Often streams with sedimentation impairments are also impaired pursuant to the total iron criterion for aquatic life protection and WVDEP determined that implementation of the iron TMDLs would require sediment reductions sufficient to resolve the biological impacts. The sediment reduction necessary to attain iron criteria was compared to the sediment reduction necessary to resolve biological stress under a "reference watershed" approach. The approach was based on selecting watersheds with acceptable biological condition that share similar landuse, ecoregion, and geomorphologic characteristics with the watersheds of impacted streams. The normalized loading associated with the reference stream is assumed to represent the conditions needed to resolve sedimentation stress in impacted streams. A reference watershed, Panther Creek (WV-BST-83), was evaluated. Upon finalization of modeling based on the reference watershed approach, it was determined that sediment reductions necessary to ensure compliance with iron criteria are greater than those necessary to correct the biological impacts associated with sediment. As such, the iron TMDLs presented for the subject waters are appropriate surrogates to address impacts related to sediment. Refer to the Technical Report and **Appendix L** for details regarding the iron surrogate approach.

9.6 Allocation Strategy

As explained in **Section 2**, a TMDL is composed of the sum of individual WLAs for point sources, LAs for nonpoint sources, and natural background levels. In addition, the TMDL must include a MOS, implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. TMDLs can be expressed in terms of mass per time or other appropriate units. Conceptually, this definition is denoted by the equation:

$$\text{TMDL} = \text{sum of WLAs} + \text{sum of LAs} + \text{MOS}$$

To develop the TMDLs for each of the impairments listed in **Table 3-3** of this report, the following approach was taken:

- Define TMDL endpoints
- Simulate baseline conditions
- Assess source loading alternatives
- Determine the TMDL and source allocations

9.6.1 TMDL Endpoints

TMDL endpoints represent the water quality targets used to quantify TMDLs and their individual components. In general, West Virginia's numeric water quality criteria for the subject pollutants and an explicit five percent MOS were used to identify endpoints for TMDL development. The TMDL endpoints for the various criteria are displayed in **Table 9-1**.

The five percent explicit MOS was used to counter uncertainty in the modeling process. Long-term water quality monitoring data were used for model calibration. Although these data represented actual conditions, they were not of a continuous time series and might not have captured the full range of instream conditions that occurred during the simulation period.

The allocation process prescribes criterion end of pipe WLAs for continuous discharges and instream treatment structures and thereby provides an implicit MOS for criterion attainment at all model assessment locations. Similarly, an explicit MOS was not applied for total iron TMDLs in certain subwatersheds where mining point sources create an effluent dominated scenario and/or the regulated mining activity encompasses a large percentage of the watershed area. Within these scenarios, WLAs are established at the value of the criteria and little uncertainty is associated with the source/water quality linkage. The TMDL endpoints for the various criteria are displayed below.

Table 9-1. TMDL endpoints

Water Quality Criterion	Designated Use	Criterion Value	TMDL Endpoint
Dissolved Aluminum	Aquatic Life, warmwater fisheries	0.75 mg/L (1-hour average)	0.7125 mg/L (1-hour average)
Total Iron	Aquatic Life, warmwater fisheries	1.5 mg/L (4-day average)	1.425 mg/L (4-day average)
Manganese	Public Water Supply	1.0 ml/L (Annual Geometric Mean)	0.95 ml/L (Annual Geometric Mean)
pH	Aquatic Life	6.00 Standard Units (Minimum)	6.02 Standard Units (Minimum)
Fecal Coliform	Water Contact Recreation and Public Water Supply	200 counts / 100 mL (Monthly Geometric Mean)	190 counts / 100 mL (Monthly Geometric Mean)
Fecal Coliform	Water Contact Recreation and Public Water Supply	400 counts / 100 mL (Daily, 10% exceedance)	380 counts / 100 mL (Daily, 10% exceedance)

TMDLs are presented as average daily loads that were developed to meet TMDL endpoints under a range of conditions observed throughout the year. For most pollutants, analysis of available data indicated that critical conditions occur during both high- and low-flow events. To appropriately address the low- and high-flow critical conditions, the TMDLs were developed using continuous simulation (modeling over a period of several years that captured precipitation extremes), which inherently considers seasonal hydrologic and source loading variability.

9.6.2 Baseline Conditions and Source Loading Alternatives

The calibrated model provides the basis for performing the allocation analysis. The first step is to simulate baseline conditions, which represent point sources loadings at permit limits and existing nonpoint source loadings. Baseline conditions allow for an evaluation of instream water quality under the highest expected loading conditions.

Baseline Conditions for MDAS

The MDAS model was run for baseline conditions using hourly precipitation data for a representative six-year simulation period (January 1, 2014 through December 31, 2019). The precipitation experienced over this period was applied to the landuses and pollutant sources as they existed at the time of TMDL development. Predicted instream concentrations were compared directly with the TMDL endpoints. This comparison allowed for the evaluation of the magnitude and frequency of exceedances under a range of hydrologic and environmental conditions, including dry periods, wet periods, and average periods. **Figure 9-3** presents the seasonal rainfall totals for the years 2010 through 2020 at the Huntington Tri-State Airport (WBAN 03860) weather station near Ceredo, West Virginia. The years 2014 to 2019 are highlighted to indicate the range of precipitation conditions used for TMDL development in the Tug Fork River watershed.

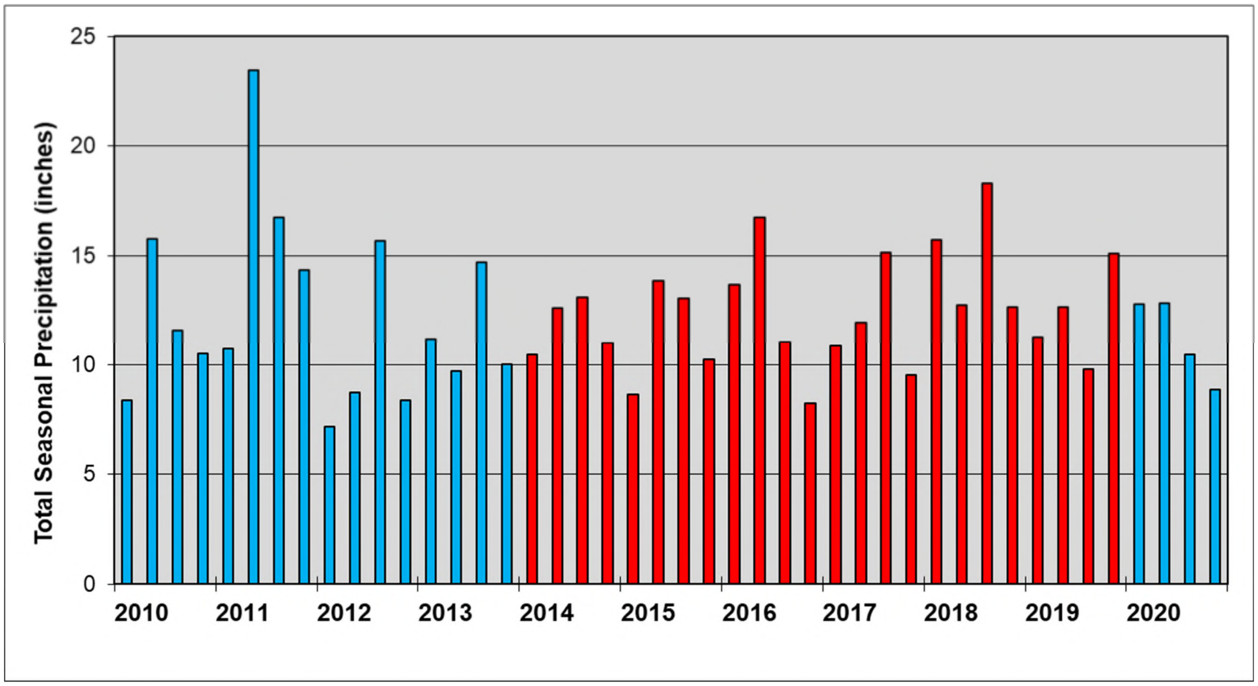


Figure 9-3. Seasonal precipitation totals for the Huntington Tri-State Airport (WBAN 03860) weather station

In the baseline condition, flow from mining discharges that are primarily influenced by precipitation was represented based upon precipitation and drainage area. For non-precipitation-driven mining discharges, flow representation was based upon provided flow or pump capacity information. Baseline iron concentrations for mining discharges were established at one of three standardized constant values, with classification informed by existing outlet effluent limitations:

- 3.2 mg Fe/L - this concentration best represents the effluent limitation set that results from implementation of the technology-based requirements of 40 CFR 434
- 1.5 mg Fe/L - this concentration best represents the limitation set that results from end-of-pipe application of the West Virginia warmwater aquatic life protection criterion for total iron.
- 1 mg Fe/L - this concentration best represents the limitation set that results from end-of-pipe application of the West Virginia trout water aquatic life protection criterion for total iron.

The above concentrations are generally consistent with the existing limitation sets for the majority of mining discharges. For outlets with existing limit sets that vary from the standard values, the baseline iron concentration was established at the next higher value. Existing wasteload allocations that fell between 1.5 and 3.2 were set to 3.2, those that fell between 1.0 and 1.5 were set to 1.5 and those that were less than 1.0 were set to 1.0.

In order to establish allocated load, 2.5 percent of the total subwatershed area was allotted for concurrent construction activity under the CSGP, where possible. Baseline loadings were based upon precipitation and runoff and an assumption that proper installation and maintenance of required BMPs will achieve a Total Suspended Solids (TSS) benchmark value of 100 mg/L.

Sediment producing nonpoint source and background loadings were represented using precipitation, drainage area, and the iron loading associated with their predicted sediment contributions.

Effluents from sewage treatment plants were represented under baseline conditions as continuous discharges, using the design flow for each facility and the monthly geometric mean fecal coliform effluent limitation of 200 counts/100 mL. Baseline characteristics for non-stormwater industrial wastewater sources were obtained from effluent limitations and other permitting information.

CSO outlets were represented as discreet point sources in the model. CSO flow and discharge frequency was derived from overflow data supplied by the POTWs, when available. This information was augmented with precipitation analysis and watershed modeling to develop model inputs needed to build fecal coliform loading values for a ten-year time series from which annual average fecal coliform loading values could be calculated. CSO effluent was represented in the model at a concentration of 100,000 counts/100 mL to reflect baseline conditions for untreated CSO discharges.

Source Loading Alternatives

Simulating baseline conditions allowed for the evaluation of each stream's response to variations in source contributions under a variety of hydrologic conditions. Performing this sensitivity analysis gave insight into the dominant sources and the mechanisms by which potential decreases in loads would affect instream pollutant concentrations. The loading contributions from the various existing sources were individually adjusted; the modeled instream concentrations were then evaluated.

Multiple allocation scenarios were run for the impaired waterbodies. Successful scenarios achieved the TMDL endpoints under all flow conditions throughout the modeling period. The averaging period and allowable exceedance frequency associated with West Virginia water quality criteria were considered in these assessments. In general, loads contributed by sources that had the greatest impact on instream concentrations were reduced first. If additional load reductions were required to meet the TMDL endpoints, less significant source contributions were subsequently reduced.

Figure 9-4 shows an example of model output for a baseline condition and a successful TMDL scenario.

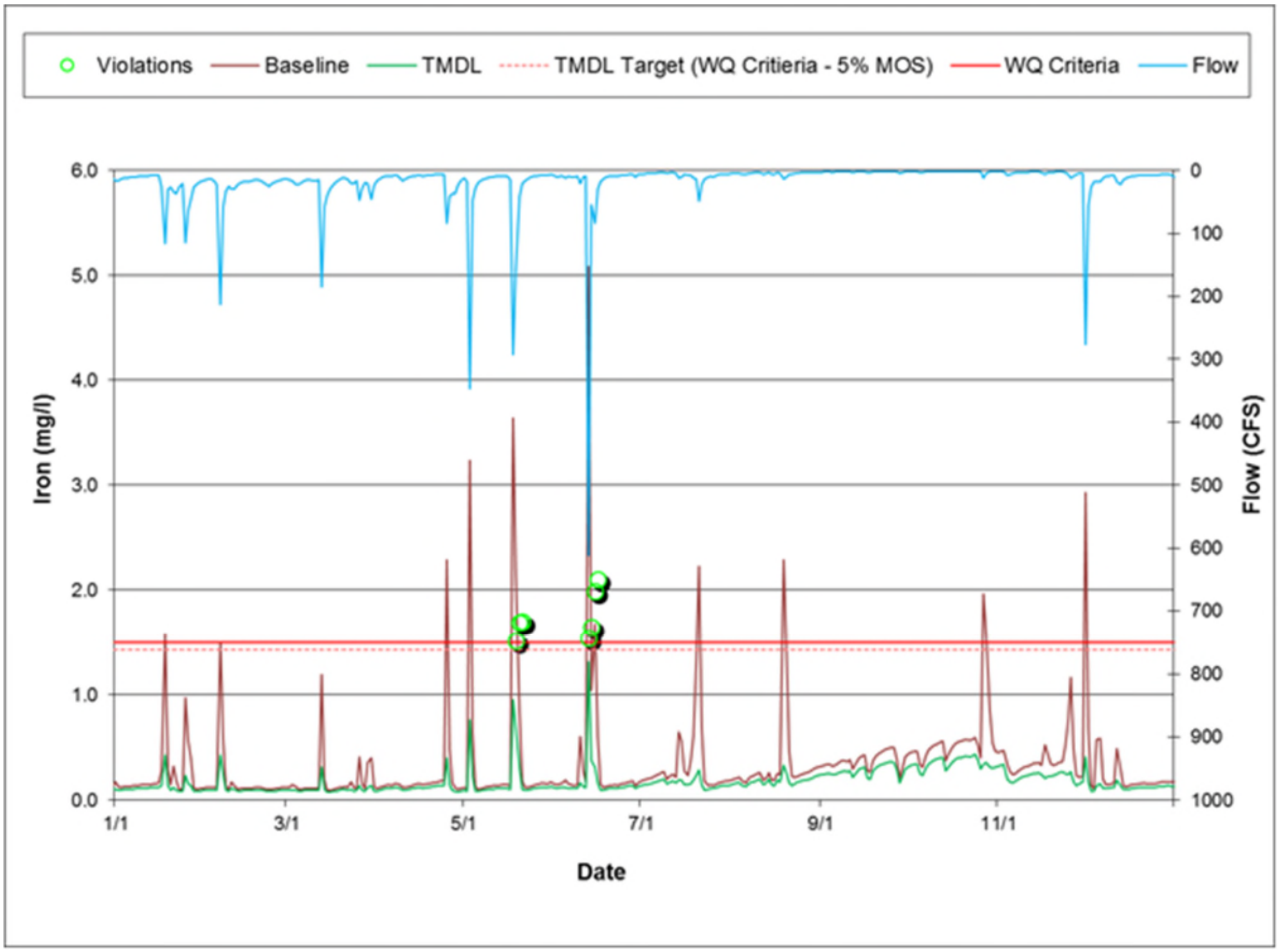


Figure 9-4. Example of baseline and TMDL conditions for total iron

9.7 TMDLs and Source Allocations

9.7.1 Total Iron TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the iron impaired streams of the Tug Fork River watersheds. In order to meet iron criterion and allow for equitable allocations, reductions to existing sources were first assigned using the following iterative steps in a series of model runs, reducing in the next step when needed to meet the TMDL endpoint:

1. The loading from streambank erosion was first reduced to the loading characteristics of the streams with the best observed streambank conditions.
2. The following land disturbing sources were equitably reduced to the iron loading associated with 100 mg/L TSS.
    - Barren
    - Cropland
    - Pasture

- Urban/MS4 Pervious
- Oil and Gas
- Unpaved Roads
- Forestry Skid Roads and Landings

3. Harvested Forest was reduced to the sediment and iron loading associated with Forest.
4. AMD seeps were reduced to water quality criterion end of pipe (1.5 mg/L iron).
5. Active mining permits and other point sources discharging to warm-water streams were reduced to water quality criterion end of pipe (1.5 mg/L iron) in subwatersheds where the model indicated non-attainment after reductions associated with Steps 1-4. Likewise, active mining permits in trout streams were reduced to 1.0 mg/L iron in subwatersheds where the model indicated non-attainment after reductions associated with Steps 1-4. If one mining-related outlet with a technology-based permit limit within a subwatershed was reduced, all other outlets with a technology-based permit limit in the same subwatershed were reduced.
6. Reductions to iron sources in Kentucky and Virginia tributary watersheds necessary to meet West Virginia iron water quality criterion in the Tug Fork mainstem as described in Section 3.2.

In addition to reducing the streambank erosion and source contributions, activity under the CSGP and OGCSGP was considered. Area based WLAs were provided for each subwatershed to accommodate existing and future registrations under the CSGP or OGCSGP. Two and a half (2.5) percent of the subwatershed area was allocated for activity in almost all subwatersheds to account for future growth.

After executing the above provisions, model output was evaluated to determine the criterion attainment status at all subwatershed pour points.

Using this method ensured that contributions from all sources were weighted equitably and that cumulative load endpoints were met at the most downstream subwatershed for each impaired stream. Reductions in sources affecting impaired headwaters ultimately led to improvements downstream and effectively decreased necessary loading reductions from downstream sources. Nonpoint source reductions did not result in allocated loadings less than natural conditions.

Prescribed wasteload allocations for permitted sources are not more stringent than applicable water quality criteria or existing effluent limits for NPDES permitted outlets. Some NPDES permitted outlets have existing antidegradation-based effluent limitations that are reflective of an iron wasteload allocation less than 1.0 mg Fe/L and were represented by a baseline concentration equal to 1.0 mg Fe/L as discussed in Section 9.6.2. Because such sources were not reduced in the allocation process, presented wasteload allocation are equal to the baseline concentration. For such outlets, the TMDL prescribed wasteload allocations do not require pollutant reductions, nor are they intended to relax antidegradation-based limits as discussed below.

Wasteload Allocations (WLAs)

WLAs were developed for all point sources permitted to discharge iron under a NPDES permit. Because of the established relationship between iron and TSS, iron WLAs are also provided for facilities with stormwater discharges that are regulated under NPDES permits that contain TSS and/or iron effluent limitations or benchmarks values, and facilities registered under the General NPDES permit for construction stormwater.

Active Mining Operations

WLAs are provided for all existing outlets of NPDES permits for mining activities, except those where reclamation has progressed to the point where existing limitations are based upon the Post-Mining Area provisions of Subpart E of 40 CFR 434. The WLAs for active mining operations consider the functional characteristics of the permitted outlets (i.e. precipitation driven, pumped continuous flow, gravity continuous flow, commingled) and their respective impacts at high and low flow conditions.

The federal effluent guidelines for the coal mining point source category (40 CFR 434) provide various alternative limitations for discharges caused by precipitation. Under those technology-based guidelines, effluent limitations for total iron and TSS may be replaced with an alternative limitation for "settleable solids" during certain magnitude precipitation events that vary by mining subcategory. The water quality-based WLAs and future growth provisions of the iron TMDLs preclude the applicability of the "alternative precipitation" iron provisions of 40 CFR 434. Also, the established relationship between iron and TSS requires continuous control of TSS concentration in permitted discharges to achieve iron WLAs. As such, the "alternative precipitation" TSS provisions of 40 CFR 434 should not be applied to point source discharges associated with the iron TMDLs.

The limits set forth in the NPDES permits for the point sources were calculated in a site-specific manner consistent with West Virginia's anti-degradation procedures and West Virginia's NPDES permit regulations. This TMDL is not intended to serve as a basis for relaxation of effluent limitations in existing permits pursuant to CWA Section 303(d)(4)(A)(i) or otherwise, nor is this TMDL intended to serve as a basis for departing from applicable regulations and processes for calculating water quality-based effluent limitations to address site-specific conditions.

Specific WLAs are not provided for "post-mining" outlets because programmatic reclamation was assumed to have returned disturbed areas to conditions that approach background. Barring unforeseen circumstances that alter their current status, such outlets are authorized to continue to discharge under the existing terms and conditions of their NPDES permit.

Bond Forfeiture Sites

WLAs were established for bond forfeiture sites. Baseline iron conditions were generally established under the same protocols used for active mining operations. In instances where effluent characteristics were not directly available, baseline conditions were established at the technology based effluent limits of 40 CFR 434 and reduced as necessary to attain the TMDL endpoints.

Discharges regulated by the Multi Sector Stormwater Permit

Certain registrations under the general permit for stormwater associated with industrial activity implement TSS and/or iron benchmark values. Facilities that are compliant with such limitations are not considered to be significant sources of sediment or iron. Facilities that are present in the watersheds of iron-impaired streams are assigned WLAs that allow for continued discharge under existing permit conditions, whether those requirements are expressed in effluent limits or benchmark values. BMP based limits constitute acceptable implementation of the wasteload allocations for stormwater discharges.

Municipal Separate Storm Sewer System (MS4)

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for stormwater discharges from MS4s. Each entity will be registered under, and subject to, the requirements of General Permit Number WV0110625. The stormwater discharges from MS4s are point sources for which the TMDLs prescribe WLAs. In the TMDL watersheds of the Tug Fork there are no designated MS4 entities.

Construction Stormwater

Specific WLAs for activity under the CSGP are provided at the subwatershed scale and are described in **Section 9.6.2**. With several exceptions, an allocation of 2.5 percent of undeveloped subwatershed area was provided with loadings based upon precipitation and runoff and an assumption that required BMPs, if properly installed and maintained, will achieve a TSS benchmark value of 100 mg/L. These construction stormwater allocations are displayed as acreages by subwatershed in the CSW_Future_Growth tab of the Iron TMDL Allocation spreadsheet provided with this report. In certain areas, the existing level of activity under the CSGP does not conform to the subwatershed allocations. In these instances the WVDEP, DWWM permitting program will require stabilization and permit termination in the shortest time possible. Thereafter the program will maintain concurrently disturbed area as allocated or otherwise control future activity through provisions described in **Section 11**.

Other Non-mining Point Sources

Non-stormwater municipal and industrial sources for which existing NPDES permits did not contain iron were not considered to be substantive sources and were not explicitly represented in the modeling. A list of such negligible sources appears in **Appendix F** of the Technical Report. Existing discharges from negligible sources do not require wasteload allocations pursuant to the iron TMDLs. Any metals loading associated with such sources is contained in the background loading and accounted for in model calibration.

Load Allocations (LAs)

LAs are made for the dominant nonpoint source categories as follows:

- AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps. Also includes loads from abandoned mine areas associated with remining permits.
- Sediment sources: loading associated with sediment contributions from barren land, forestry skid roads and landings, oil and gas well operations, agricultural landuses, and residential/urban/road landuses and streambank erosion in non-MS4 areas.

- Background sources: loading from undisturbed forest and grasslands (loadings associated with this category were represented but not reduced).

9.7.2 Dissolved Aluminum and pH TMDLs

Source allocations were developed for all modeled subwatersheds contributing to the dissolved aluminum and/or pH impaired streams of the Tug Fork River watershed. The allocation approach focused on reducing metals concentrations and increasing pH by assigning buffering capacity (alkalinity) using the MDAS model to meet metals water quality criteria and then verifying that the resultant pH under these conditions would be in compliance with pH criteria.

Aluminum and pH are dynamically affected by chemical interactions with dissolved metals constituents in the water column. Dissolved aluminum and pH model results were evaluated under the modeled instream water chemistry conditions created by reductions to iron sources necessary to achieve the iron TMDL endpoint. Modeled iron source reductions necessary for iron TMDL development were performed first, using a step-wise approach described in **Section 9.7.1**. Those source reductions were held constant during model runs for aluminum and pH TMDL development. If aluminum and pH model results predicted non-attainment of the pH and dissolved aluminum criteria, then alkalinity additions were prescribed, and total aluminum was reduced from primary causative sources such as AML seeps.

Initially, the pH and aluminum model was calibrated against observed data to quantify certain characteristics of sources, such as the aluminum partitioning ratio between solid and dissolved phases. The baseline metal and hydrogen acidity loadings from sources were used to estimate the required alkalinity and total aluminum reduction necessary to achieve improved water quality conditions for pH and aluminum concentrations. If criteria were not met, acidity and metal sources were evaluated and prioritized per subwatershed based on the source loading magnitude. In keeping with the same allocation philosophy used for iron TMDL development, significant sources of aluminum and pH (e.g., seeps) were reduced first. To raise pH, alkalinity was applied to offset the pollutant loads from modeled sources to achieve the pH criterion.

In some instances, acidity released from instream metal precipitation lowered the pH and resulted in re-suspension of dissolved aluminum. If these reactions resulted in non-attainment of pH and/or dissolved aluminum criteria, additional alkalinity was prescribed to seeps and then mining sources of acidity.

The mitigation of acid loadings by alkalinity addition coupled with reductions of total aluminum loading from land-based sources are predicted to result in attainment of both dissolved aluminum and pH water quality criteria at all evaluated locations in the pH and dissolved aluminum impaired streams.

Wasteload Allocations (WLAs)

Active mining NPDES point sources were present in aluminum, manganese and pH impaired streams in the Tug Fork River Watershed. WLAs were developed for active point source discharges by starting with their current NPDES permit effluent limits and design flows.

No non-mining point sources were present in the one pH and aluminum impaired watershed for which TMDLs were developed. Had they been present, baseline loadings from non-mining point sources, including facilities registered under the Construction Stormwater General Permits, would have been represented to properly account for aluminum associated with sediment sources. Negligible amounts of acidity or dissolved aluminum are typically attributed to these sources, thus no reductions are typically necessary and aluminum-specific control actions would have been prescribed.

Load Allocations (LAs)

LAs of total aluminum and acidity were determined for contributing nonpoint source categories as follows:

- AML: loading from abandoned mine lands, including loads from highwalls, deep mine discharges and seeps, as well as loadings from abandoned mine areas associated with remining permits.
- Other nonpoint sources: loading associated with acid precipitation influences from barren land, harvested forest, oil and gas well operations, agriculture, and residential/urban/road landuses.
- Background sources: loading associated with acid precipitation influences from undisturbed forest, wetlands, and grasslands.

All sources were represented and provided allocations in terms of the total aluminum and net acidity loadings. No reductions were prescribed for background nonpoint sources. For abandoned mine sources, aluminum allocations represent the background loading from precipitation runoff from land and the reduced loads from AML seeps.

Baseline and TMDL load allocations (LAs) include the natural background sources of buffering capacity. The TMDLs prescribe additional acidity reduction (alkalinity addition) for acidic sources to meet instream pH water quality criterion and associated aluminum reductions.

9.7.3 Total Manganese TMDLs

Thacker Creek (WV-BST-61_01) was subject to manganese TMDL development because it is within a five mile zone upstream of the Matewan Water Works drinking water intake. The water quality criterion for streams in this zone is an annual geomean not to exceed 1 mg/l manganese. A TMDL allocation scenario with all significant sources reduced to 1 mg/l was able to reduce the baseline manganese concentration to below the water quality criterion, but not below the MOS concentration of 0.95 mg/l. An explicit MOS is not necessary at this specific location, because the source of manganese is certain as are needed reductions to attain water quality standards.

Wasteload Allocations (WLAs)

WLAs were developed for all mining related point source discharges into impaired streams in the Tug Fork River watershed. WLAs for active mining operations considered the functional characteristics of the permitted outlets (i.e. precipitation driven, pumped continuous flow, or commingled) and their respective impacts at high and low flow conditions. WLAs were based on the water column concentration of 1 mg/l, which is protective of drinking water use 5 miles upstream of an intake.

Load Allocations (LAs)

LAs were developed for background sources, and other nonpoint sources. LAs were divided into several landuse categories: undisturbed forest and grasslands; abandoned mine lands; and legacy mine areas that include forfeited or closed permits. Remining permits were also present in the Thacker Creek watershed. Legacy mine areas were reduced to the water quality criterion. AML seeps were also reduced to the water quality criterion.

9.7.4 Fecal Coliform Bacteria TMDLs

TMDLs and source allocations were developed for impaired streams and their tributaries on a subwatershed basis throughout the watershed. The following general methodology was used when allocating loads to fecal coliform bacteria sources:

- The effluents from all NPDES permitted sewage treatment plants were set at the permit limit (200 counts/100 mL monthly geometric mean)
- Because West Virginia Bureau for Public Health regulations prohibit the discharge of raw sewage into surface waters, all illicit discharges of human waste (from failing septic systems and straight pipes) were reduced by 100 percent in the model
- All CSO discharges were assigned WLAs at the value of the fecal coliform water quality criterion (200 counts/100ml); and
- If further reductions were necessary, MS4s, non-point source loadings from agricultural lands and residential areas were subsequently reduced until instream water quality criteria were met.

Wasteload Allocations (WLAs)

WLAs were developed for all facilities permitted to discharge fecal coliform bacteria, including MS4s, as described below.

Sewage Treatment Plant Effluents

The fecal coliform effluent limitations for NPDES permitted sewage treatment plants are more stringent than water quality criteria, therefore, all effluent discharges from sewage treatment facilities were given WLAs equal to existing monthly fecal coliform effluent limitations of 200 counts/100 mL. When there are permitted stormwater outlets at sewage treatment plants, BMP based limits constitute acceptable implementation of the wasteload allocations for stormwater discharges.

Combined Sewer Overflows

In TMDL watersheds there are a total of 2 CSO outlets associated with the POTW operated by the City of Welch (WV0024589).

All fecal coliform bacteria WLAs for CSO discharges have been established at 200 counts/100mL. Implementation can be accomplished by CSO elimination or by disinfection treatment to make the discharge be in compliance with the operable, concentration-based allocations.

In establishing the WLAs for CSOs, WVDEP first considered the appropriateness of mixing zones for bacteria. WVDEP concluded that mixing zones would allow elevated levels of bacteria that may not conform to the mixing zone provisions at 47 CSR 2 §5.2.c., 5.2.g. and 5.2.h.3. Because 47 CSR 2 §5.2.c. prohibits pollutant concentrations greater than criteria for the protection of human health at any point unless a mixing zone has been assigned, the CSO WLAs were established at the value of the fecal coliform water quality criterion.

It is important to note that even if mixing zone rules are alternatively interpreted or changed in the future, dilution is generally not available to allow CSO allocations to be substantively greater than criteria. In previous projects, WVDEP used the calibrated model to examine the magnitude of CSO allocations that could be shown to result in criteria attainment when coupled with the allocations for other sources prescribed in this project and demonstrated nonattainment at multiple modeled locations when CSO were modestly increased above 200 counts/100 ml.

Municipal Separate Storm Sewer System (MS4)

USEPA's stormwater permitting regulations require municipalities to obtain permit coverage for stormwater discharges from MS4s. Each entity will be registered under, and subject to, the requirements of General Permit Number WV0110625. The stormwater discharges from MS4s are point sources for which the TMDLs prescribe WLAs. There are no MS4s in the Tug Fork River watershed.

Load Allocations (LAs)

Fecal coliform LAs are assigned to the following source categories:

- Pasture/Cropland
- On-site Sewage Systems — loading from all illicit discharges of human waste (including failing septic systems and straight pipes)
- Residential — loading associated with urban/residential runoff from non-MS4 areas
- Background and Other Nonpoint Sources — loading associated with wildlife sources from all other landuses (contributions/loadings from wildlife sources were not reduced)

- Kentucky and Virginia agricultural, residential, and failing septic system nonpoint sources were reduced to allow the Tug Fork Mainstem to meet West Virginia water quality criteria as described in Section 3.2

9.7.5 Seasonal Variation

Seasonal variation was considered in the formulation of the modeling analysis. Continuous simulation (modeling over a period of several years that captured precipitation extremes) inherently considers seasonal hydrologic and source loading variability**.** The pollutant concentrations simulated on a daily time step by the model were compared with TMDL endpoints. Allocations that met these endpoints throughout the modeling period were developed.

9.7.6 Critical Conditions

A critical condition represents a scenario where water quality criteria are most susceptible to violation. Analysis of water quality data for the impaired streams addressed in this effort shows high pollutant concentrations during both high- and low-flow thereby precluding selection of a single critical condition. Both high-flow and low-flow periods were taken into account during TMDL development by using a long period of weather data that represented wet, dry, and average flow periods.

Nonpoint source loading is typically precipitation-driven and impacts tend to occur during wet weather and high surface runoff. During dry periods little or no land-based runoff occurs, and elevated instream pollutant levels may be due to point sources (Novotny and Olem, 1994).

9.7.7 TMDL Presentation

The TMDLs for all impairments are shown in **Section 10** of this report. Loads are divided into assessment units. The TMDLs for iron, aluminum, and manganese are presented as average daily loads derived from annual loads, in pounds per day. TMDLs for pH are presented as average daily net acidity load expressed in pounds of $CaCO_3$/day equivalent derived from annual loads. The TMDLs for fecal coliform bacteria are presented in average number of colonies per day derived from annual colonies. All TMDLs were developed to meet TMDL endpoints under a range of conditions observed over the modeling period. TMDLs and their components are also presented in the allocation spreadsheets associated with this report. The filterable spreadsheets also display detailed source allocations and include multiple display formats that allow comparison of pollutant loadings among categories and facilitate implementation of the TMDL to restore the waterbody.

Maximum daily loads derived from maximum in-stream concentrations are described in the technical report and presented in **Appendix M**.

The iron WLAs for active outlets of mining operations and bond forfeiture sites are presented both as annual average loads, for comparison with other pollutant sources, and equivalent allocation concentrations. The prescribed concentrations are the operable allocations and are to be implemented by conversion to monthly average and daily maximum effluent limitations using USEPA’s Technical Support Document for Water Quality-based Toxics Control (USEPA, 1991).

Where multiple lines for the same NPDES permit and subwatershed are provided, they are indicative of the different baseline conditions /permit limitations associated with the outlets of that permit in that subwatershed. Appendix F - HPU Metals Model Outlets provides a list of outlets included in the modeling project and associated information regarding their baseline representation to assist in wasteload allocation implementation. In the event that this TMDL does not provide wasteload allocations for specific point sources due to inadvertent omission, such sources may be permitted if effluent limitations are prescribed based upon a wasteload allocation concentration equal to the TMDL endpoint, as further described in Section 11 Future Growth.

The iron WLAs for future CSGP registrations are presented as both annual average loads (for comparison with other sources) and equivalent areas registered under the permit. The registered area is the operable allocation. The iron WLAs for non-construction sectors registered under the Multi Sector Stormwater Permit are also presented both as annual average loads (for comparison with other pollutant sources) and equivalent allocation concentrations. The prescribed concentrations are operable, and because they are equivalent to existing effluent limitations/benchmark values, they are to be directly implemented.

The fecal coliform bacteria WLAs for sewage treatment plant effluents and CSOs are presented both as annual average loads (for comparison with other pollutant sources) and equivalent allocation concentrations. The prescribed concentrations are the operable allocations for NPDES permit implementation.

This TMDL does not mandate change to the form of regulation in existing NPDES permits that regulate stormwater discharges under the BMP basis and include benchmark values and monitoring to assess BMP effectiveness, when values are less than or equal to specified concentration-based wasteload allocations.

The maximum daily loads for instream conditions are described in the Technical Report. **Appendix M** of the Technical Report displays the maximum daily loads by assessment unit.

10.0 TMDL RESULTS

Table 10-1. Iron TMDLs

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Tug Fork	WV-BST_02	Tug Fork	WVBST	7.99	5.52	0.71	14.22
Tug Fork	WV-BST_04	Tug Fork	WVBST	62.02	171.34	12.28	245.64
Tug Fork	WV-BST_05	Tug Fork	WVBST	109.93	264.76	19.72	394.41
Tug Fork	WV-BST_06	Tug Fork	WVBST	273.75	477.52	39.54	790.81
Tug Fork	WV-BST_07	Tug Fork	WVBST	372.57	492.68	45.54	910.79
Tug Fork	WV-BST_08	Tug Fork	WVBST	1,547.31	962.98	132.12	2,642.41
Tug Fork	WV-BST_09	Tug Fork	WVBST	5,051.88	1,201.15	329.11	6,582.13
Tug Fork	WV-BST_10	Tug Fork	WVBST	10,159.71	1,832.76	631.18	12,623.65
Mill Creek	WV-BST-2_03	Mill Creek	WVBST-1	36.82	6.13	2.26	45.21
Mill Creek	WV-BST-2_02	Mill Creek	WVBST-1	25.33	4.56	1.57	31.46
Mill Creek	WV-BST-2-S-6_01	Rush Branch	WVBST-1-E-3	1.50	0.31	0.10	1.91
Mill Creek	WV-BST-2-T-5_01	Grassy Branch	WVBST-1-D-1	2.09	0.44	0.13	2.67
Powdermill Branch	WV-BST-8_01	Powdermill Branch	WVBST-3	1.10	8.82	0.52	10.44
Bull Branch	WV-BST-9_01	Bull Branch	WVBST-4	1.13	0.23	0.07	1.44
Stone Branch	WV-BST-10_01	Stone Branch	WVBST-5	0.76	0.18	0.05	1.00
Drag Creek	WV-BST-16_01	Drag Creek	WVBST-10	5.46	1.21	0.35	7.02
Bull Creek	WV-BST-21_02	Bull Creek	WVBST-14	8.84	1.85	0.56	11.26
Lick Branch	WV-BST-24_01	Lick Branch	WVBST-15	0.86	0.15	0.05	1.07
Jennie Creek	WV-BST-26_03	Jennie Creek	WVBST-17	16.36	27.40	2.30	46.07
Jennie Creek	WV-BST-26_02	Jennie Creek	WVBST-17	12.63	23.05	1.88	37.55
Jennie Creek	WV-BST-26_01	Jennie Creek	WVBST-17	5.09	15.94	1.11	22.14

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Jennie Creek	WV-BST-26-M_01	Upper Honey Branch	WVBST-17-F	0.62	1.91	0.13	2.67
Stonecoal Creek	WV-BST-27_01	Stonecoal Creek	WVBST-18	3.09	5.02	0.43	8.54
Marrowbone Creek	WV-BST-29_03	Marrowbone Creek	WVBST-19	26.93	52.91	4.20	84.05
Marrowbone Creek	WV-BST-29_02	Marrowbone Creek	WVBST-19	12.27	35.64	2.52	50.43
Marrowbone Creek	WV-BST-29-A_01	Vinson Branch	WVBST-19-A	0.87	0.14	0.05	1.07
Marrowbone Creek	WV-BST-29-C_01	Left Fork/Marrowbone Creek	WVBST-19-B	2.51	0.58	0.16	3.25
Marrowbone Creek	WV-BST-29-J_01	Neely Branch	WVBST-19-F	1.73	5.41	0.38	7.52
Upper Burning Creek	WV-BST-32_01	Upper Burning Creek	WVBST-22	3.45	14.49	0.94	18.89
Parsley Big Branch	WV-BST-33_01	Parsley Big Branch	WVBST-23	1.65	0.40	0.11	2.16
Pigeon Creek	WV-BST-35_06	Pigeon Creek	WVBST-24	235.13	497.32	38.55	770.99
Pigeon Creek	WV-BST-35_05	Pigeon Creek	WVBST-24	156.43	320.96	25.13	502.52
Pigeon Creek	WV-BST-35_04	Pigeon Creek	WVBST-24	95.41	235.16	17.40	347.97
Pigeon Creek	WV-BST-35_03	Pigeon Creek	WVBST-24	35.78	100.85	7.19	143.82
Pigeon Creek	WV-BST-35_02	Pigeon Creek	WVBST-24	19.56	83.74	5.44	108.73
Pigeon Creek	WV-BST-35_01	Pigeon Creek	WVBST-24	8.43	51.69	3.16	63.28
Pigeon Creek	WV-BST-35-AA_01	Millstone Branch	WVBST-24-O	1.11	0.34	0.08	1.52
Pigeon Creek	WV-BST-35-AF_03	Rockhouse Fork	WVBST-24-Q	19.56	40.35	3.15	63.07
Pigeon Creek	WV-BST-35-AF_01	Rockhouse Fork	WVBST-24-Q	6.49	14.16	1.09	21.74
Pigeon Creek	WV-BST-35-AF-11_01	Spring Branch	WVBST-24-Q-7	1.53	8.47	0.53	10.53
Pigeon Creek	WV-BST-35-AF-4_01	Upper Curry Branch	WVBST-24-Q-4	0.38	5.42	0.31	6.11
Pigeon Creek	WV-BST-35-AF-7_01	Big Pigeonroost Branch	WVBST-24-Q-6	1.62	3.66	0.28	5.56
Pigeon Creek	WV-BST-35-AM_01	UNT/Pigeon Creek RM 20.01	WVBST-24-S.3	0.44	0.08	0.03	0.55
Pigeon Creek	WV-BST-35-AS_01	Oldfield Branch	WVBST-24-T	1.20	3.59	0.25	5.05
Pigeon Creek	WV-BST-35-BE_01	Grant Branch	WVBST-24-DD	1.29	16.47	0.93	18.69
Pigeon Creek	WV-BST-35-BG_01	Thacker Fork	WVBST-24-FF	0.85	32.69	1.77	35.31
Pigeon Creek	WV-BST-35-E_01	Big Branch	WVBST-24-B	3.89	29.20	1.74	34.83

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
Pigeon Creek	WV-BST-35-K_04	Laurel Fork/Pigeon Creek	WVBST-24-E	34.24	144.94	9.43	188.61
Pigeon Creek	WV-BST-35-K_02	Laurel Fork/Pigeon Creek	WVBST-24-E	10.89	46.57	3.02	60.49
Pigeon Creek	WV-BST-35-K-1_01	Right Fork/Laurel Fork/Pigeon Creek	WVBST-24-E-1	3.42	20.20	1.24	24.86
Pigeon Creek	WV-BST-35-K-10_01	Paw Paw Branch	WVBST-24-E-7	0.84	1.07	0.10	2.01
Pigeon Creek	WV-BST-35-K-11_01	UNT/Laurel Fork RM 9.61	WVBST-24-E-7.3	0.69	2.59	0.17	3.45
Pigeon Creek	WV-BST-35-K-16_01	Panther Branch	WVBST-24-E-8	0.74	4.54	0.28	5.55
Pigeon Creek	WV-BST-35-K-1-F_01	Buck Branch	WVBST-24-E-1-B	0.52	0.17	0.04	0.73
Pigeon Creek	WV-BST-35-K-1-H_01	Bubby Branch	WVBST-24-E-1-D	0.56	4.85	0.28	5.69
Pigeon Creek	WV-BST-35-K-3_01	Spruce Fork	WVBST-24-E-2	3.61	44.36	2.52	50.50
Pigeon Creek	WV-BST-35-K-3-A_01	Left Fork/Spruce Fork	WVBST-24-E-2-A	2.29	19.99	1.17	23.45
Pigeon Creek	WV-BST-35-K-7_01	Rockhouse Branch	WVBST-24-E-5	0.51	11.93	0.65	13.09
Pigeon Creek	WV-BST-35-S_03	Trace Fork	WVBST-24-K	24.91	63.15	4.63	92.69
Pigeon Creek	WV-BST-35-S_02	Trace Fork	WVBST-24-K	18.11	47.86	3.47	69.44
Pigeon Creek	WV-BST-35-S-10_01	Right Fork/Trace Fork	WVBST-24-K-4	4.94	18.94	1.26	25.14
Pigeon Creek	WV-BST-35-Z_02	Elk Creek	WVBST-24-N	13.04	19.78	1.73	34.55
Pigeon Creek	WV-BST-35-Z-10_01	Left Fork/Elk Creek	WVBST-24-N-4	3.42	11.93	0.81	16.16
Road Branch	WV-BST-38_01	Road Branch	WVBST-26	2.56	0.51	0.16	3.23
Miller Creek	WV-BST-39_02	Miller Creek	WVBST-27	10.23	33.44	2.30	45.97
Miller Creek	WV-BST-39_01	Miller Creek	WVBST-27	3.74	20.79	1.29	25.81
Dans Branch	WV-BST-43_01	Dans Branch	WVBST-29	1.60	0.37	0.10	2.07
Buffalo Creek	WV-BST-45_01	Buffalo Creek	WVBST-31	8.24	5.31	0.71	14.26
Sugartree Creek	WV-BST-46_01	Sugartree Creek	WVBST-32	1.99	0.41	0.13	2.52
Williamson Creek	WV-BST-47_01	Williamson Creek	WVBST-33	1.58	0.25	0.10	1.92
Sycamore Creek	WV-BST-48_01	Sycamore Creek	WVBST-34	4.58	0.94	0.29	5.81
Lick Creek	WV-BST-49_01	Lick Creek	WVBST-35	3.40	0.64	0.21	4.26
Lick Creek	WV-BST-49-C_01	UNT/Lick Creek RM 2.14		0.29	0.00	0.02	0.31

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Dick Williamson Branch	WV-BST-50_01	Dick Williamson Branch	WVBST-36	1.18	0.23	0.07	1.49
Sprouse Creek	WV-BST-54_01	Sprouse Creek	WVBST-38	0.41	17.42	0.94	18.77
Ferrell Branch	WV-BST-55_01	Ferrell Branch	WVBST-39	1.73	5.43	0.38	7.53
Ferrell Branch	WV-BST-55-B_01	UNT/Ferrell Branch RM 0.83	WVBST-39-B	0.38	0.54	0.05	0.97
Mate Creek	WV-BST-57_03	Mate Creek	WVBST-40	22.06	14.85	1.94	38.85
Mate Creek	WV-BST-57_02	Mate Creek	WVBST-40	13.83	13.10	1.42	28.35
Mate Creek	WV-BST-57_01	Mate Creek	WVBST-40	6.45	8.20	0.77	15.43
Mate Creek	WV-BST-57-B_01	Rutherford Branch	WVBST-40-B	1.37	0.29	0.09	1.74
Mate Creek	WV-BST-57-D_01	Mitchell Branch	WVBST-40-C	1.92	0.51	0.13	2.56
Mate Creek	WV-BST-57-G_01	Chafin Branch	WVBST-40-D	0.75	0.77	0.08	1.60
Mate Creek	WV-BST-57-K_01	Double Camp Fork	WVBST-40-H	1.41	3.16	0.24	4.80
Mate Creek	WV-BST-57-K-1_01	UNT/Double Camp Fork RM 1.36		0.02	2.81	0.15	2.97
Mate Creek	WV-BST-57-L_01	Straight Fork	WVBST-40-I	2.77	3.00	0.30	6.07
Sulphur Creek	WV-BST-58_01	Sulphur Creek	WVBST-41	0.94	0.24	0.06	1.25
Thacker Creek	WV-BST-61_01	Thacker Creek	WVBST-42	6.21	58.45	3.40	68.07
Thacker Creek	WV-BST-61-A_01	Scissorsville Branch	WVBST-42-A	1.27	4.94	0.33	6.53
Thacker Creek	WV-BST-61-B_01	Mauchlinville Branch	WVBST-42-B	0.24	17.62	0.94	18.80
Grapevine Creek	WV-BST-62_01	Grapevine Creek	WVBST-43	3.56	37.58	2.17	43.30
Grapevine Creek	WV-BST-62-A_01	Lick Fork	WVBST-43-A	0.38	9.65	0.53	10.56
Grapevine Creek	WV-BST-62-B_01	Wolfpen Fork	WVBST-43-B	0.40	8.10	0.45	8.95
Grapevine Creek	WV-BST-62-C_01	Millseat Branch	WVBST-43-B.5	0.34	13.37	0.72	14.43
Sand Branch	WV-BST-64_01	Sand Branch	WVBST-44	0.36	1.51	0.10	1.98
Beech Creek	WV-BST-67-D_01	Grapevine Fork	WVBST-46-B	1.19	9.29	0.55	11.03
Beech Creek	WV-BST-67-D-1_01	UNT/Grapevine Fork RM 0.22	WVBST-46-B-1	0.07	5.91	0.31	6.29
Tug Fork	WV-BST-70_01	Laurel Branch	WVBST-49	0.68	0.15	0.04	0.87
Ben Creek	WV-BST-74_03	Ben Creek	WVBST-52	26.30	105.80	6.95	139.06

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Ben Creek	WV-BST-74_02	Ben Creek	WVBST-52	14.12	44.38	3.08	61.58
Ben Creek	WV-BST-74_01	Ben Creek	WVBST-52	3.33	37.92	2.17	43.43
Ben Creek	WV-BST-74-D_01	Left Fork/Ben Creek	WVBST-52-B	5.07	47.84	2.79	55.70
Ben Creek	WV-BST-74-L_01	White Oak Hollow	WVBST-52-G.5	0.64	0.13	0.04	0.81
Fourpole Creek	WV-BST-78_01	Fourpole Creek	WVBST-56	6.56	4.61	0.59	11.76
Bull Creek	WV-BST-79_01	Bull Creek	WVBST-57	7.68	6.89	0.77	15.34
Bull Creek	WV-BST-79-D_01	Left Fork/Bull Creek	WVBST-57-B	6.20	0.94	0.38	7.52
Mohawk Branch	WV-BST-80_01	Mohawk Branch	WVBST-58	0.58	1.81	0.13	2.52
Longpole Creek	WV-BST-81-J_01	Panther Fork	WVBST-59-B	0.66	9.74	0.55	10.95
Panther Creek	WV-BST-83_04	Panther Creek	WVBST-60	55.95	15.18	3.74	74.88
Panther Creek	WV-BST-83_03	Panther Creek	WVBST-60	25.72	4.45	1.59	31.75
Panther Creek	WV-BST-83-E_01	Cub Branch	WVBST-60-D	0.52	0.10	0.03	0.65
Panther Creek	WV-BST-83-I_01	Hurricane Branch	WVBST-60-G	2.15	5.07	0.38	7.59
Panther Creek	WV-BST-83-P_01	Meathouse Fork	WVBST-60-H	8.32	1.48	0.52	10.32
Horse Creek	WV-BST-88_01	Horse Creek	WVBST-63	4.90	2.77	0.40	8.08
Horse Creek	WV-BST-88-D_01	UNT/Horse Creek RM 1.52		0.33	1.39	0.09	1.81
War Branch	WV-BST-91_01	War Branch	WVBST-65	1.67	7.80	0.50	9.97
Tug Fork	WV-BST-95_01	Rock Branch	WVBST-68	0.82	1.97	0.15	2.93
Johnnycake Branch	WV-BST-96-C_01	UNT/Johnnycake Branch RM 1.76	WVBST-69-C	0.53	1.82	0.12	2.48
Dry Fork	WV-BST-98_04	Dry Fork	WVBST-70	64.04	32.83	5.10	101.96
Dry Fork	WV-BST-98_03	Dry Fork	WVBST-70	52.78	20.93	3.88	77.59
Dry Fork	WV-BST-98-A_01	Coon Branch	WVBST-70-A	0.89	0.24	0.06	1.18
Dry Fork	WV-BST-98-AD_01	Atwell Branch	WVBST-70-O	1.00	1.78	0.15	2.93
Dry Fork	WV-BST-98-AP_01	Pruett Branch	WVBST-70-S	0.89	0.42	0.07	1.38
Dry Fork	WV-BST-98-AQ_01	Barrenshe Creek	WVBST-70-T	2.87	12.57	0.81	16.25
Dry Fork	WV-BST-98-AQ-5_01	Clear Fork Branch	WVBST-70-T-2	1.59	2.66	0.22	4.48

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Dry Fork	WV-BST-98-AT-10_01	Big Branch	WVBST-70-U-1	3.07	0.68	0.20	3.95
Dry Fork	WV-BST-98-AT-10-F_01	UNT/Big Branch RM 1.28	WVBST-70-U-1-F	1.39	0.34	0.09	1.82
Dry Fork	WV-BST-98-AW_04	Jacobs Fork	WVBST-70-W	84.02	55.51	7.34	146.87
Dry Fork	WV-BST-98-AW_03	Jacobs Fork	WVBST-70-W	72.39	31.10	5.45	108.94
Dry Fork	WV-BST-98-AW-24-C_01	UNT/Horsepen Creek RM 1.48	WVBST-70-W-6-0.5A	0.07	2.74	0.15	2.96
Dry Fork	WV-BST-98-AW-24-K_01	Low Gap Branch	WVBST-70-W-6-B	7.87	1.23	0.48	9.59
Dry Fork	WV-BST-98-AW-3-E_01	UNT/Big Creek RM 1.98	WVBST-70-W-1-0.7A	0.41	3.61	0.21	4.22
Dry Fork	WV-BST-98-AW-3-F_01	Mountain Fork	WVBST-70-W-1-A	5.28	1.17	0.34	6.79
Dry Fork	WV-BST-98-AW-3-Z_01	Middle Fork/Big Creek	WVBST-70-W-1-G	1.00	0.47	0.08	1.55
Dry Fork	WV-BST-98-BO_03	Beech Fork	WVBST-70-AA	19.38	13.68	1.74	34.81
Dry Fork	WV-BST-98-BO-1_01	31 Hollow (Right Fork/Beech Fork)	WVBST-70-AA-1	4.53	10.67	0.80	16.00
Dry Fork	WV-BST-98-H_01	Mile Branch	WVBST-70-C	2.53	4.28	0.36	7.18
Dry Fork	WV-BST-98-L_01	Grapevine Branch	WVBST-70-F	0.78	0.21	0.05	1.04
Dry Fork	WV-BST-98-O_01	Beartown Branch	WVBST-70-I	2.07	1.77	0.20	4.05
Dry Fork	WV-BST-98-W-10_01	Wolfpen Branch	WVBST-70-M-3	1.05	10.36	0.60	12.01
Dry Fork	WV-BST-98-W-6_01	Groundhog Branch	WVBST-70-M-1	0.97	0.26	0.06	1.29
Dry Fork	WV-BST-98-W-8_01	Hite Fork	WVBST-70-M-2	8.66	3.89	0.66	13.21
Dry Fork	WV-BST-98-W-8-A_01	Middle Fork/Hite Fork	WVBST-70-M-2-A	2.69	2.57	0.28	5.54
Dry Fork	WV-BST-98-W-8-B_01	Dry Monday Branch	WVBST-70-M-2-B	2.78	0.64	0.18	3.60
Dry Fork	WV-BST-98-Z_03	Little Slate Creek	WVBST-70-N	12.35	2.85	0.80	16.00
Dry Fork	WV-BST-98-Z_01	Little Slate Creek	WVBST-70-N	3.94	0.98	0.26	5.18
Dry Fork	WV-BST-98-Z-13_01	Mudlick Branch	WVBST-70-N-2	2.89	0.65	0.19	3.72
Dry Fork	WV-BST-98-Z-6_01	Right Fork/Little Slate Creek	WVBST-70-N-1	1.43	0.28	0.09	1.80
Lick Branch	WV-BST-100_01	Lick Branch	WVBST-71	1.00	1.83	0.15	2.98
Tug Fork	WV-BST-101_01	Harman Branch	WVBST-72	2.08	1.17	0.17	3.41

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Clear Fork	WV-BST-106_03	Clear Fork	WVBST-76	17.10	4.83	1.15	23.08
Clear Fork	WV-BST-106_02	Clear Fork	WVBST-76	6.85	2.09	0.47	9.41
Clear Fork	WV-BST-106_01	Clear Fork	WVBST-76	1.80	0.56	0.12	2.49
Clear Fork	WV-BST-106-M_01	Crane Trace Branch	WVBST-76-C	1.33	0.39	0.09	1.81
Clear Fork	WV-BST-106-Q_01	Daycamp Branch	WVBST-76-E	0.97	0.30	0.07	1.34
Spice Creek	WV-BST-109_02	Spice Creek	WVBST-78	7.78	2.40	0.54	10.71
Spice Creek	WV-BST-109_01	Spice Creek	WVBST-78	3.38	1.03	0.23	4.63
Spice Creek	WV-BST-109-A_01	Shabbyroom Branch	WVBST-78-B	0.79	0.26	0.06	1.10
Spice Creek	WV-BST-109-G_01	Honeycamp Branch	WVBST-78-D	0.54	0.42	0.05	1.01
Spice Creek	WV-BST-109-H_01	Coontree Branch	WVBST-78-E	0.40	0.13	0.03	0.55
Spice Creek	WV-BST-109-I_01	Stonecoal Branch	WVBST-78-F	0.47	0.13	0.03	0.63
Spice Creek	WV-BST-109-J_01	Badway Branch	WVBST-78-G	0.42	0.13	0.03	0.58
Spice Creek	WV-BST-109-L_01	Newson Branch	WVBST-78-H	0.35	0.10	0.02	0.47
Spice Creek	WV-BST-109-M_01	Moorecamp Branch	WVBST-78-I	0.19	0.06	0.01	0.27
Tug Fork	WV-BST-121_01	Twin Branch	WVBST-84	2.01	0.64	0.14	2.79
Davy Branch	WV-BST-123_01	Davy Branch	WVBST-85	3.42	2.83	0.33	6.58
Davy Branch	WV-BST-123-A_01	Left Fork/Davy Branch	WVBST-85-A	1.04	0.33	0.07	1.44
Davy Branch	WV-BST-123-G_01	UNT/Davy Branch RM 3.28	WVBST-85-G	0.27	0.36	0.03	0.67
Shannon Branch	WV-BST-132_01	Shannon Branch	WVBST-94	1.83	3.54	0.28	5.65
Upper Shannon Branch	WV-BST-133_01	Upper Shannon Branch	WVBST-95	1.32	3.66	0.26	5.25
Browns Creek	WV-BST-137_02	Browns Creek	WVBST-98	5.52	18.24	1.25	25.02
Browns Creek	WV-BST-137-D_01	Puncheoncamp Branch	WVBST-98-A	1.30	12.77	0.74	14.81
Browns Creek	WV-BST-137-H_01	Trail Fork	WVBST-98-B	1.24	4.55	0.30	6.10
Elkhorn Creek	WV-BST-138_05	Elkhorn Creek	WVBST-99	62.84	178.23	12.69	253.76
Elkhorn Creek	WV-BST-138_04	Elkhorn Creek	WVBST-99	40.43	118.98	8.39	167.80
Elkhorn Creek	WV-BST-138_03	Elkhorn Creek	WVBST-99	12.90	28.13	2.16	43.19

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Elkhorn Creek	WV-BST-138_01	Elkhorn Creek	WVBST-99	7.00	14.89	1.15	23.04
Elkhorn Creek	WV-BST-138-AH_01	Johns Knob Branch	WVBST-99-O	0.70	0.22	0.05	0.97
Elkhorn Creek	WV-BST-138-AJ_01	UNT/Elkhorn Creek RM 20.15	WVBST-99-O.7	0.39	1.55	0.10	2.04
Elkhorn Creek	WV-BST-138-AM_01	Angle Hollow	WVBST-99-Q	1.88	8.29	0.54	10.71
Elkhorn Creek	WV-BST-138-AM-1_01	Little Fork	WVBST-99-Q-1	0.46	5.47	0.31	6.24
Elkhorn Creek	WV-BST-138-E_01	Mill Creek	WVBST-99-A	0.99	1.06	0.11	2.16
Elkhorn Creek	WV-BST-138-O_01	Laurel Branch	WVBST-99-E	5.59	11.86	0.92	18.36
Elkhorn Creek	WV-BST-138-P_01	Rockhouse Branch	WVBST-99-F	0.39	12.46	0.68	13.53
Elkhorn Creek	WV-BST-138-Q_01	Bottom Creek	WVBST-99-G	2.04	27.58	1.56	31.18
Elkhorn Creek	WV-BST-138-Q-3_01	UNT/Bottom Creek RM 2.88		0.42	15.86	0.86	17.13
Elkhorn Creek	WV-BST-138-V_01	Coalbank Branch	WVBST-99-I	2.56	15.74	0.96	19.27
Elkhorn Creek	WV-BST-138-V-2_01	UNT/Coalbank Branch RM 0.58	WVBST-99-I-0.6	0.42	3.57	0.21	4.20
Elkhorn Creek	WV-BST-138-V-3_01	UNT/Coalbank Branch RM 0.82	WVBST-99-I-0.7	0.91	5.68	0.35	6.93
Elkhorn Creek	WV-BST-138-V-4_01	Dans Branch	WVBST-99-I-1	0.16	3.73	0.21	4.10
Elkhorn Creek	WV-BST-138-V-5_01	UNT/Coalbank Branch RM 1.43	WVBST-99-I-2	0.22	2.12	0.12	2.46
Elkhorn Creek	WV-BST-138-X_01	Burk Creek	WVBST-99-K	0.83	18.15	1.00	19.98
Elkhorn Creek	WV-BST-138-X-1_01	UNT/Burk Creek RM 0.72		0.04	15.83	0.84	16.70
Elkhorn Creek	WV-BST-138-Z_01	North Fork/Elkhorn Creek	WVBST-99-L	5.15	1.68	0.36	7.19
Elkhorn Creek	WV-BST-138-Z-1_01	Buzzard Branch	WVBST-99-L-1	3.97	16.16	1.06	21.19
Elkhorn Creek	WV-BST-138-Z-3_01	Bearwallow Branch	WVBST-99-L-2	1.08	11.75	0.68	13.51
Little Indian Creek	WV-BST-139_01	Little Indian Creek	WVBST-100	1.48	0.47	0.10	2.06
Jed Branch	WV-BST-142_01	Jed Branch	WVBST-102	0.37	0.85	0.06	1.29
Rock Narrows Branch	WV-BST-143_01	Rock Narrows Branch	WVBST-103	1.01	2.19	0.17	3.37
Harris Branch	WV-BST-144_01	Harris Branch	WVBST-104	0.18	3.67	0.20	4.05
Mitchell Branch	WV-BST-146_01	Mitchell Branch	WVBST-105	0.97	1.85	0.15	2.97

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Sugarcamp Branch	WV-BST-147_01	Sugarcamp Branch	WVBST-106	1.39	0.51	0.10	2.00
Grapevine Branch	WV-BST-149_01	Grapevine Branch	WVBST-107	0.11	5.48	0.29	5.89
Tug Fork	WV-BST-150_01	Mill Creek	WVBST-108	2.65	3.47	0.32	6.44
Sandlick Creek	WV-BST-152_02	Sandlick Creek	WVBST-109	8.63	23.57	1.69	33.89
Sandlick Creek	WV-BST-152_01	Sandlick Creek	WVBST-109	2.72	5.77	0.45	8.94
Sandlick Creek	WV-BST-152-A_01	Right Fork/Sandlick Creek	WVBST-109-A	1.60	0.49	0.11	2.19
Sandlick Creek	WV-BST-152-B_01	UNT/Sandlick Creek RM 1.61		0.07	2.38	0.13	2.59
Sandlick Creek	WV-BST-152-C_01	Left Fork/Sandlick Creek	WVBST-109-B	2.92	10.45	0.70	14.07
Sandlick Creek	WV-BST-152-C-3_01	UNT/Left Fork RM 0.89/Sandlick Creek	WVBST-109-B-3	1.10	6.02	0.37	7.50
Adkin Branch	WV-BST-153_01	Adkin Branch	WVBST-110	1.13	2.16	0.17	3.46
Belcher Branch	WV-BST-154_01	Belcher Branch	WVBST-111	0.93	6.48	0.39	7.79
Turnhole Branch	WV-BST-155_01	Turnhole Branch	WVBST-112	0.94	0.31	0.07	1.32
Harmon Branch	WV-BST-156_01	Harmon Branch	WVBST-113	1.82	13.58	0.81	16.21
Leslie Branch	WV-BST-157_01	Leslie Branch	WVBST-114	0.68	13.58	0.75	15.01
South Fork/Tug Fork	WV-BST-163_03	South Fork/Tug Fork	WVBST-115	13.79	68.48	4.33	86.61
South Fork/Tug Fork	WV-BST-163_02	South Fork/Tug Fork	WVBST-115	5.94	46.87	2.78	55.59
South Fork/Tug Fork	WV-BST-163_01	South Fork/Tug Fork	WVBST-115	3.30	43.40	2.46	49.15
South Fork/Tug Fork	WV-BST-163-B_01	Tea Branch	WVBST-115-A	0.30	1.32	0.09	1.71
South Fork/Tug Fork	WV-BST-163-D_01	McClure Branch	WVBST-115-B	0.26	0.88	0.06	1.20
South Fork/Tug Fork	WV-BST-163-E_01	Milam Branch	WVBST-115-C	0.49	2.29	0.15	2.92
South Fork/Tug Fork	WV-BST-163-F_01	Jump Branch	WVBST-115-D	0.83	11.64	0.66	13.13
South Fork/Tug Fork	WV-BST-163-G_01	Spice Creek	WVBST-115-E	2.46	5.00	0.39	7.85
South Fork/Tug Fork	WV-BST-163-J_01	Laurel Branch	WVBST-115-F	1.77	0.56	0.12	2.45
South Fork/Tug Fork	WV-BST-163-K_01	Road Fork	WVBST-115-G	0.68	7.14	0.41	8.24

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Iron TMDL (lbs/day)
South Fork/Tug Fork	WV-BST-163-M-1_01	UNT/UNT RM 0.04/South Fork RM 5.46/Tug Fork	WVBST-115-I-1	0.32	2.04	0.12	2.48
South Fork/Tug Fork	WV-BST-163-N-1_01	UNT/UNT RM 0.15/South Fork RM 5.85/Tug Fork	WVBST-115-J-1	0.01	5.22	0.27	5.50
Belcher Branch	WV-BST-166_01	Belcher Branch	WVBST-116	0.01	12.46	0.66	13.13
Loop Branch	WV-BST-168_01	Loop Branch	WVBST-117	1.06	2.68	0.20	3.94
Mill Branch	WV-BST-170_01	Mill Branch	WVBST-118	0.97	9.86	0.57	11.41
Dry Branch	WV-BST-173_01	Dry Branch	WVBST-119	0.24	1.32	0.08	1.65
Little Creek	WV-BST-174_01	Little Creek	WVBST-120	5.76	11.79	0.92	18.47
Little Creek	WV-BST-174-B_01	Indian Grave Branch	WVBST-120-A	0.59	4.23	0.25	5.08
Little Creek	WV-BST-174-C_01	Puncheoncamp Branch	WVBST-120-B	1.02	4.53	0.29	5.84
UNT/Little Creek RM 2.34	WV-BST-174-E_01	UNT/Little Creek RM 2.34		0.49	1.09	0.08	1.66
Millseat Branch	WV-BST-178_01	Millseat Branch	WVBST-121	1.71	0.53	0.12	2.35
Ballard Harmon Branch	WV-BST-179_01	Ballard Harmon Branch	WVBST-122	1.07	0.59	0.09	1.75
Sams Branch	WV-BST-181_01	Sams Branch	WVBST-123	1.14	0.27	0.07	1.49

UNT = unnamed tributary; RM = river mile.

Table 10-2. pH TMDL

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	LA daily average net acidity load under TMDL condition (lbs as CaCO3/day)	WLA daily average net acidity load under TMDL condition (lbs as CaCO3/day)	MOS daily average net acidity load (lbs as CaCO3/day)	TMDL daily average net acidity load (lbs as CaCO3/day)
Pigeon Creek	WV-BST-35-AM_01	UNT/Pigeon Creek RM 20.01	WVBST-24-S.3	-216.8	0.0	-11.4	-228.2
Thacker Creek	WV-BST-61_01	Thacker Creek	WVBST-42	-6831.7	-241.2	-372.3	-7445.2
Mohawk Branch	WV-BST-80_01	Mohawk Branch	WVBST-58	-208.4	-114.6	-17.0	-340.0
Dry Fork	WV-BST-98-H_01	Mile Branch	WVBST-70-C	-854.4	-219.5	-56.5	-1130.5
Dry Fork	WV-BST-98-H-2_01	UNT/Mile Branch RM 0.98	WVBST-70-C-2	-236.7	-111.3	-18.3	-366.4
Dry Fork	WV-BST-98-H-2-A_01	UNT/UNT RM 0.34/Mile Branch RM 0.98	WVBST-70-C-2-A	-95.4	-31.2	-6.7	-133.2
Sandlick Creek	WV-BST-152-C-3-A_01	UNT/UNT RM 0.01/Left Fork RM 0.89/Sandlick Creek	WVBST-109-B-3-A	-143.1	-170.7	-16.5	-330.3

Table 10-3. Aluminum TMDL

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Al TMDL (lbs/day)
Thacker Creek	WV-BST-61_01	Thacker Creek	WVBST-42	34.35	2.76	1.95	39.07
Mohawk Branch	WV-BST-80_01	Mohawk Branch	WVBST-58	0.09	1.28	0.07	1.44
Dry Fork	WV-BST-98-H-2_01	UNT/Mile Branch RM 0.98	WVBST-70-C-2	0.20	2.17	0.12	2.49

Table 10-4. Manganese TMDL

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocation (lbs/day)	Wasteload Allocation (lbs/day)	Margin of Safety (lbs/day)	Mn TMDL (lbs/day)
Thacker Creek	WV-BST-61_01	Thacker Creek	WVBST-42	46.01	3.82	2.62	52.45

Table 10-5. Fecal Coliform Bacteria TMDLs

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Tug Fork	WV-BST_01	Tug Fork	WVBST	3.00E+09		1.58E+08	3.16E+09
Tug Fork	WV-BST_02	Tug Fork	WVBST	8.13E+09		4.28E+08	8.56E+09
Tug Fork	WV-BST_03	Tug Fork	WVBST	2.10E+10	3.79E+06	1.11E+09	2.21E+10
Tug Fork	WV-BST_04	Tug Fork	WVBST	4.50E+10	7.58E+06	2.37E+09	4.74E+10
Tug Fork	WV-BST_05	Tug Fork	WVBST	6.69E+10	5.69E+09	3.82E+09	7.64E+10
Tug Fork	WV-BST_06	Tug Fork	WVBST	1.52E+11	1.48E+10	8.80E+09	1.76E+11
Tug Fork	WV-BST_07	Tug Fork	WVBST	1.88E+11	1.51E+10	1.07E+10	2.13E+11
Tug Fork	WV-BST_08	Tug Fork	WVBST	6.28E+11	1.80E+10	3.40E+10	6.80E+11
Tug Fork	WV-BST_09	Tug Fork	WVBST	1.86E+12	2.88E+10	9.95E+10	1.99E+12
Tug Fork	WV-BST_10	Tug Fork	WVBST	3.50E+12	3.29E+10	1.86E+11	3.72E+12
Mill Creek	WV-BST-2_02	Mill Creek	WVBST-1	2.77E+10	4.55E+07	1.46E+09	2.92E+10
Mill Creek	WV-BST-2_03	Mill Creek	WVBST-1	4.17E+10	5.30E+07	2.20E+09	4.40E+10
Mill Creek	WV-BST-2-E_01	Paddle Creek	WVBST-1-A	3.76E+09	3.79E+06	1.98E+08	3.96E+09
Mill Creek	WV-BST-2-S_01	Left Fork/Mill Creek	WVBST-1-E	8.67E+09	3.79E+06	4.56E+08	9.13E+09
Mill Creek	WV-BST-2-S-6_01	Rush Branch	WVBST-1-E-3	2.05E+09	3.79E+06	1.08E+08	2.16E+09
Mill Creek	WV-BST-2-T_01	Right Fork/Mill Creek	WVBST-1-D	8.99E+09		4.73E+08	9.47E+09

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Powdermill Branch	WV-BST-8_01	Powdermill Branch	WVBST-3	1.44E+09		7.60E+07	1.52E+09
Stone Branch	WV-BST-10_01	Stone Branch	WVBST-5	7.49E+08		3.94E+07	7.88E+08
Lost Creek	WV-BST-12_01	Lost Creek	WVBST-7	1.41E+09		7.44E+07	1.49E+09
Lost Creek	WV-BST-12_02	Lost Creek	WVBST-7	8.48E+09	3.79E+06	4.47E+08	8.93E+09
Lost Creek	WV-BST-12-M_01	Right Fork/Lost Creek	WVBST-7-D	1.20E+09		6.31E+07	1.26E+09
Drag Creek	WV-BST-16_01	Drag Creek	WVBST-10	4.74E+09	3.79E+06	2.49E+08	4.99E+09
Drag Creek	WV-BST-16-C_01	Painter Branch	WVBST-10-0.5A	5.04E+08		2.65E+07	5.30E+08
Camp Creek	WV-BST-18_01	Camp Creek	WVBST-12	2.95E+09		1.55E+08	3.10E+09
Peters Branch	WV-BST-19_01	Peters Branch	WVBST-13	4.22E+08		2.22E+07	4.44E+08
Bull Creek	WV-BST-21_01	Bull Creek	WVBST-14	3.15E+09		1.66E+08	3.31E+09
Bull Creek	WV-BST-21_02	Bull Creek	WVBST-14	9.24E+09	7.58E+06	4.87E+08	9.73E+09
Bull Creek	WV-BST-21-E_01	Right Fork/Bull Creek	WVBST-14-B	3.32E+09	3.79E+06	1.75E+08	3.50E+09
Lick Branch	WV-BST-24_01	Lick Branch	WVBST-15	7.25E+08	1.14E+07	3.88E+07	7.75E+08
Silver Creek	WV-BST-25_01	Silver Creek	WVBST-16	1.97E+09		1.04E+08	2.07E+09
Jennie Creek	WV-BST-26_01	Jennie Creek	WVBST-17	5.16E+09	4.90E+08	2.97E+08	5.95E+09
Jennie Creek	WV-BST-26_02	Jennie Creek	WVBST-17	1.28E+10	4.90E+08	7.00E+08	1.40E+10
Jennie Creek	WV-BST-26_03	Jennie Creek	WVBST-17	1.75E+10	5.09E+08	9.49E+08	1.90E+10
Stonecoal Creek	WV-BST-27_01	Stonecoal Creek	WVBST-18	4.24E+09		2.23E+08	4.47E+09
Marrowbone Creek	WV-BST-29_02	Marrowbone Creek	WVBST-19	1.26E+10		6.63E+08	1.33E+10
Marrowbone Creek	WV-BST-29_03	Marrowbone Creek	WVBST-19	2.75E+10		1.45E+09	2.90E+10
Marrowbone Creek	WV-BST-29-M_01	Laurel Branch	WVBST-19-I	1.81E+09		9.51E+07	1.90E+09
Marrowbone Creek	WV-BST-29-O_01	Antley Branch	WVBST-19-J	9.68E+08		5.09E+07	1.02E+09
Parsley Big Branch	WV-BST-33_01	Parsley Big Branch	WVBST-23	1.63E+09		8.58E+07	1.72E+09
Pigeon Creek	WV-BST-35_03	Pigeon Creek	WVBST-24	3.30E+10	2.38E+08	1.75E+09	3.50E+10
Pigeon Creek	WV-BST-35_04	Pigeon Creek	WVBST-24	9.16E+10	2.14E+09	4.93E+09	9.86E+10
Pigeon Creek	WV-BST-35_06	Pigeon Creek	WVBST-24	1.96E+11	2.59E+09	1.05E+10	2.09E+11

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Pigeon Creek	WV-BST-35-E_01	Big Branch	WVBST-24-B	8.19E+09	9.79E+06	4.32E+08	8.63E+09
Pigeon Creek	WV-BST-35-J_01	Mill Branch	WVBST-24-D	5.70E+08		3.00E+07	6.00E+08
Pigeon Creek	WV-BST-35-K_02	Laurel Fork/Pigeon Creek	WVBST-24-E	9.86E+09		5.19E+08	1.04E+10
Pigeon Creek	WV-BST-35-K_03	Laurel Fork/Pigeon Creek	WVBST-24-E	3.12E+10		1.64E+09	3.28E+10
Pigeon Creek	WV-BST-35-K_04	Laurel Fork/Pigeon Creek	WVBST-24-E	4.29E+10	7.58E+06	2.26E+09	4.52E+10
Pigeon Creek	WV-BST-35-K-1_01	Right Fork/Laurel Fork/Pigeon Creek	WVBST-24-E-1	4.13E+09		2.17E+08	4.34E+09
Pigeon Creek	WV-BST-35-K-1_02	Right Fork/Laurel Fork/Pigeon Creek	WVBST-24-E-1	9.40E+09	7.58E+06	4.95E+08	9.90E+09
Pigeon Creek	WV-BST-35-K-3_01	Spruce Fork	WVBST-24-E-2	6.72E+09		3.54E+08	7.08E+09
Pigeon Creek	WV-BST-35-M_01	Oldhouse Branch	WVBST-24-F.5	4.89E+08		2.58E+07	5.15E+08
Pigeon Creek	WV-BST-35-O_01	UNT/Pigeon Creek RM 6.72 (White Branch)	WVBST-24-G	3.84E+08		2.02E+07	4.04E+08
Pigeon Creek	WV-BST-35-P_01	Hensley Big Branch	WVBST-24-H	2.58E+09		1.36E+08	2.71E+09
Pigeon Creek	WV-BST-35-R_01	Ruth Trace Branch	WVBST-24-J	8.62E+08		4.54E+07	9.07E+08
Pigeon Creek	WV-BST-35-S_03	Trace Fork	WVBST-24-K	2.83E+10	2.47E+08	1.50E+09	3.00E+10
Pigeon Creek	WV-BST-35-S-8_01	Riffe Branch	WVBST-24-K-2	3.56E+09		1.87E+08	3.75E+09
Pigeon Creek	WV-BST-35-S-10_01	Right Fork/Trace Fork	WVBST-24-K-4	5.06E+09	2.38E+08	2.79E+08	5.57E+09
Pigeon Creek	WV-BST-35-S-10-B_01	Left Fork/Right Fork/Trace Fork	WVBST-24-K-4-A	1.71E+09		8.97E+07	1.79E+09
Pigeon Creek	WV-BST-35-S-13_01	Dingess Camp Branch	WVBST-24-K-7	7.05E+08		3.71E+07	7.42E+08
Pigeon Creek	WV-BST-35-S-15_01	Simmons Fork	WVBST-24-K-8	7.67E+08		4.03E+07	8.07E+08
Pigeon Creek	WV-BST-35-T_01	Conley Branch	WVBST-24-L	1.60E+09		8.41E+07	1.68E+09
Pigeon Creek	WV-BST-35-V_01	Hell Creek	WVBST-24-M	3.07E+09		1.61E+08	3.23E+09
Pigeon Creek	WV-BST-35-Z_02	Elk Creek	WVBST-24-N	1.40E+10		7.36E+08	1.47E+10
Pigeon Creek	WV-BST-35-Z-6_01	Fivemile Creek	WVBST-24-N-2	1.85E+09		9.75E+07	1.95E+09
Pigeon Creek	WV-BST-35-Z-9_01	Middle Fork/Elk Creek	WVBST-24-N-5	2.99E+09		1.57E+08	3.15E+09
Pigeon Creek	WV-BST-35-AA_01	Millstone Branch	WVBST-24-O	1.44E+09		7.56E+07	1.51E+09
Pigeon Creek	WV-BST-35-AC_01	Pigeonroost Creek	WVBST-24-P	1.23E+09		6.48E+07	1.30E+09
Pigeon Creek	WV-BST-35-AF_03	Rockhouse Fork	WVBST-24-Q	2.50E+10	8.33E+06	1.32E+09	2.64E+10

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Pigeon Creek	WV-BST-35-AF-6_01	South Branch/Rockhouse Fork	WVBST-24-Q-5	8.15E+08		4.29E+07	8.58E+08
Pigeon Creek	WV-BST-35-AF-7_01	Big Pigeonroost Branch	WVBST-24-Q-6	1.94E+09		1.02E+08	2.04E+09
Pigeon Creek	WV-BST-35-AG_01	Stonecoal Branch	WVBST-24-Q.5	1.69E+09		8.89E+07	1.78E+09
Pigeon Creek	WV-BST-35-AS_01	Oldfield Branch	WVBST-24-T	1.53E+09		8.04E+07	1.61E+09
Pigeon Creek	WV-BST-35-AT_01	Bird Branch	WVBST-24-U	5.86E+08		3.08E+07	6.17E+08
Pigeon Creek	WV-BST-35-AX_01	Meador Branch	WVBST-24-W	4.57E+08		2.40E+07	4.81E+08
Pigeon Creek	WV-BST-35-BA_01	Rover Branch	WVBST-24-Z	8.10E+08		4.27E+07	8.53E+08
Pigeon Creek	WV-BST-35-BB_01	Slick Rock Branch	WVBST-24-AA	9.40E+08		4.95E+07	9.89E+08
Pigeon Creek	WV-BST-35-BC_01	Little Muncy Branch	WVBST-24-BB	7.25E+08		3.82E+07	7.63E+08
Dans Branch	WV-BST-43_01	Dans Branch	WVBST-29	1.55E+09	1.14E+07	8.23E+07	1.65E+09
Buffalo Creek	WV-BST-45_01	Buffalo Creek	WVBST-31	9.47E+09	3.79E+06	4.98E+08	9.97E+09
Buffalo Creek	WV-BST-45-B_01	South Fork/Buffalo Creek	WVBST-31-B	1.56E+09		8.21E+07	1.64E+09
Sugartree Creek	WV-BST-46_01	Sugartree Creek	WVBST-32	1.86E+09		9.77E+07	1.95E+09
Williamson Creek	WV-BST-47_01	Williamson Creek	WVBST-33	1.66E+09		8.75E+07	1.75E+09
Sycamore Creek	WV-BST-48_01	Sycamore Creek	WVBST-34	4.06E+09		2.14E+08	4.28E+09
Lick Creek	WV-BST-49_01	Lick Creek	WVBST-35	3.21E+09		1.69E+08	3.38E+09
Dick Williamson Branch	WV-BST-50_01	Dick Williamson Branch	WVBST-36	1.07E+09	5.30E+07	5.89E+07	1.18E+09
Mate Creek	WV-BST-57_02	Mate Creek	WVBST-40	1.52E+10		8.02E+08	1.60E+10
Mate Creek	WV-BST-57_03	Mate Creek	WVBST-40	2.58E+10		1.36E+09	2.71E+10
Mate Creek	WV-BST-57-B_01	Rutherford Branch	WVBST-40-B	1.22E+09		6.42E+07	1.28E+09
Mate Creek	WV-BST-57-D_01	Mitchell Branch	WVBST-40-C	2.48E+09		1.30E+08	2.61E+09
Mate Creek	WV-BST-57-K_01	Double Camp Fork	WVBST-40-H	2.01E+09		1.06E+08	2.11E+09
Sulphur Creek	WV-BST-58_01	Sulphur Creek	WVBST-41	8.40E+08		4.42E+07	8.84E+08
Beech Creek	WV-BST-67_02	Beech Creek	WVBST-46	1.70E+10		8.97E+08	1.79E+10
Beech Creek	WV-BST-67-D_01	Grapevine Fork	WVBST-46-B	1.90E+09		9.98E+07	2.00E+09
Beech Creek	WV-BST-67-D-1_01	UNT/Grapevine Fork RM 0.22	WVBST-46-B-1	3.76E+08		1.98E+07	3.96E+08

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Alum Creek	WV-BST-72_01	Alum Creek	WVBST-50	5.46E+09		2.87E+08	5.75E+09
Ben Creek	WV-BST-74_01	Ben Creek	WVBST-52	6.15E+09		3.24E+08	6.47E+09
Ben Creek	WV-BST-74_02	Ben Creek	WVBST-52	1.38E+10		7.28E+08	1.46E+10
Ben Creek	WV-BST-74_03	Ben Creek	WVBST-52	2.68E+10	3.92E+07	1.41E+09	2.82E+10
Ben Creek	WV-BST-74-D_02	Left Fork/Ben Creek	WVBST-52-B	1.14E+10	3.92E+07	6.04E+08	1.21E+10
Ben Creek	WV-BST-74-L_01	White Oak Hollow	WVBST-52-G.5	3.32E+08		1.75E+07	3.50E+08
Turkey Creek	WV-BST-77_01	Turkey Creek	WVBST-55	2.84E+09		1.49E+08	2.99E+09
Fourpole Creek	WV-BST-78_01	Fourpole Creek	WVBST-56	7.37E+09		3.88E+08	7.75E+09
Fourpole Creek	WV-BST-78-B_01	UNT/Fourpole Creek RM 2.87	WVBST-56-A.4	6.35E+08		3.34E+07	6.69E+08
Bull Creek	WV-BST-79_01	Bull Creek	WVBST-57	7.63E+09		4.02E+08	8.03E+09
Bull Creek	WV-BST-79_02	Bull Creek	WVBST-57	1.83E+10		9.62E+08	1.92E+10
Bull Creek	WV-BST-79-D_01	Left Fork/Bull Creek	WVBST-57-B	6.38E+09		3.36E+08	6.72E+09
Bull Creek	WV-BST-79-J_01	UNT/Bull Creek RM 4.71	WVBST-57-G	1.03E+09		5.42E+07	1.08E+09
Longpole Creek	WV-BST-81_02	Longpole Creek	WVBST-59	1.45E+10		7.64E+08	1.53E+10
Panther Creek	WV-BST-83_04	Panther Creek	WVBST-60	5.16E+10	3.18E+07	2.72E+09	5.44E+10
Panther Creek	WV-BST-83-A_01	Greenbrier Fork	WVBST-60-A	3.22E+09		1.70E+08	3.39E+09
Panther Creek	WV-BST-83-B_01	Trap Fork	WVBST-60-B	3.01E+09		1.58E+08	3.16E+09
Panther Creek	WV-BST-83-C_01	Trace Fork	WVBST-60-C	6.29E+09		3.31E+08	6.62E+09
Horse Creek	WV-BST-88_01	Horse Creek	WVBST-63	5.98E+09		3.15E+08	6.29E+09
War Branch	WV-BST-91_01	War Branch	WVBST-65	2.50E+09		1.32E+08	2.63E+09
Negro Branch	WV-BST-93_01	Negro Branch	WVBST-66	2.04E+09		1.07E+08	2.14E+09
Johnnycake Branch	WV-BST-96_01	Johnnycake Branch	WVBST-69	3.70E+09		1.95E+08	3.90E+09
Johnnycake Branch	WV-BST-96-C_01	UNT/Johnnycake Branch RM 1.76	WVBST-69-C	8.16E+08		4.29E+07	8.59E+08
Dry Fork	WV-BST-98_04	Dry Fork	WVBST-70	8.48E+10	9.79E+07	4.47E+09	8.93E+10
Dry Fork	WV-BST-98_05	Dry Fork	WVBST-70	1.70E+11	1.08E+09	8.99E+09	1.80E+11
Dry Fork	WV-BST-98_06	Dry Fork	WVBST-70	2.04E+11	1.52E+09	1.08E+10	2.17E+11

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Dry Fork	WV-BST-98_07	Dry Fork	WVBST-70	2.53E+11	1.64E+09	1.34E+10	2.68E+11
Dry Fork	WV-BST-98-A_01	Coon Branch	WVBST-70-A	1.43E+09		7.53E+07	1.51E+09
Dry Fork	WV-BST-98-H_01	Mile Branch	WVBST-70-C	1.74E+09		9.16E+07	1.83E+09
Dry Fork	WV-BST-98-J_01	Crane Creek	WVBST-70-D	5.51E+09		2.90E+08	5.80E+09
Dry Fork	WV-BST-98-K_01	Betsy Branch	WVBST-70-E	2.33E+09		1.22E+08	2.45E+09
Dry Fork	WV-BST-98-L_01	Grapevine Branch	WVBST-70-F	1.19E+09		6.26E+07	1.25E+09
Dry Fork	WV-BST-98-O_01	Beartown Branch	WVBST-70-I	2.05E+09		1.08E+08	2.16E+09
Dry Fork	WV-BST-98-V_01	Oozley Branch	WVBST-70-L	2.26E+09		1.19E+08	2.38E+09
Dry Fork	WV-BST-98-W_01	Bradshaw Creek	WVBST-70-M	5.94E+09		3.13E+08	6.25E+09
Dry Fork	WV-BST-98-W_03	Bradshaw Creek	WVBST-70-M	1.84E+10	7.58E+06	9.70E+08	1.94E+10
Dry Fork	WV-BST-98-W-6_01	Groundhog Branch	WVBST-70-M-1	1.50E+09		7.89E+07	1.58E+09
Dry Fork	WV-BST-98-W-8_01	Hite Fork	WVBST-70-M-2	7.66E+09	3.79E+06	4.03E+08	8.07E+09
Dry Fork	WV-BST-98-W-10_01	Wolfpen Branch	WVBST-70-M-3	1.62E+09		8.52E+07	1.70E+09
Dry Fork	WV-BST-98-Z_02	Little Slate Creek	WVBST-70-N	7.13E+09		3.75E+08	7.51E+09
Dry Fork	WV-BST-98-Z_03	Little Slate Creek	WVBST-70-N	9.94E+09		5.23E+08	1.05E+10
Dry Fork	WV-BST-98-AD_01	Atwell Branch	WVBST-70-O	1.36E+09		7.15E+07	1.43E+09
Dry Fork	WV-BST-98-AE_01	Johnnycake Hollow	WVBST-70-P	1.16E+09		6.11E+07	1.22E+09
Dry Fork	WV-BST-98-AF_01	Bartley Creek	WVBST-70-Q	3.22E+09		1.69E+08	3.39E+09
Dry Fork	WV-BST-98-AP_01	Pruett Branch	WVBST-70-S	9.88E+08		5.20E+07	1.04E+09
Dry Fork	WV-BST-98-AQ_02	Barrenshe Creek	WVBST-70-T	7.44E+09	1.14E+07	3.92E+08	7.84E+09
Dry Fork	WV-BST-98-AQ-5_01	Clear Fork Branch	WVBST-70-T-2	1.64E+09		8.61E+07	1.72E+09
Dry Fork	WV-BST-98-AT_02	War Creek	WVBST-70-U	8.06E+09		4.24E+08	8.48E+09
Dry Fork	WV-BST-98-AW_01	Jacobs Fork	WVBST-70-W	1.04E+10		5.47E+08	1.09E+10
Dry Fork	WV-BST-98-AW_03	Jacobs Fork	WVBST-70-W	4.13E+10		2.17E+09	4.35E+10
Dry Fork	WV-BST-98-AW_04	Jacobs Fork	WVBST-70-W	5.06E+10		2.66E+09	5.33E+10

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Dry Fork	WV-BST-98-AW_05	Jacobs Fork	WVBST-70-W	6.86E+10		3.61E+09	7.22E+10
Dry Fork	WV-BST-98-AW-3_03	Big Creek	WVBST-70-W-1	1.72E+10		9.04E+08	1.81E+10
Dry Fork	WV-BST-98-AW-10_01	Cucumber Creek	WVBST-70-W-5	2.78E+09		1.46E+08	2.93E+09
Dry Fork	WV-BST-98-AW-24_02	Horsepen Creek	WVBST-70-W-6	2.63E+10		1.38E+09	2.76E+10
Dry Fork	WV-BST-98-AW-24-C_01	UNT/Horsepen Creek RM 1.48	WVBST-70-W-6-0.5A	3.69E+08		1.94E+07	3.89E+08
Lick Branch	WV-BST-100_01	Lick Branch	WVBST-71	1.27E+09		6.66E+07	1.33E+09
Sandy Huff Branch	WV-BST-102_01	Sandy Huff Branch	WVBST-73	2.71E+09		1.42E+08	2.85E+09
Snipe Branch	WV-BST-104_01	Snipe Branch	WVBST-75	8.31E+08		4.37E+07	8.75E+08
Clear Fork	WV-BST-106_01	Clear Fork	WVBST-76	1.51E+09	1.33E+08	8.65E+07	1.73E+09
Clear Fork	WV-BST-106_02	Clear Fork	WVBST-76	5.79E+09	1.33E+08	3.12E+08	6.24E+09
Clear Fork	WV-BST-106_03	Clear Fork	WVBST-76	1.23E+10	1.33E+08	6.53E+08	1.31E+10
Clear Fork	WV-BST-106-Y_01	Wolfpen Branch	WVBST-76-I	2.13E+09		1.12E+08	2.24E+09
River Laurel Branch	WV-BST-108_01	River Laurel Branch	WVBST-77	6.51E+08		3.42E+07	6.85E+08
Spice Creek	WV-BST-109_01	Spice Creek	WVBST-78	4.81E+09	2.27E+08	2.65E+08	5.31E+09
Spice Creek	WV-BST-109_02	Spice Creek	WVBST-78	9.03E+09	2.32E+08	4.87E+08	9.74E+09
Spice Creek	WV-BST-109-A_01	Shabbyroom Branch	WVBST-78-B	8.01E+08		4.22E+07	8.44E+08
Spice Creek	WV-BST-109-H_01	Coontree Branch	WVBST-78-E	4.57E+08		2.40E+07	4.81E+08
Spice Creek	WV-BST-109-J_01	Badway Branch	WVBST-78-G	4.38E+08		2.30E+07	4.61E+08
Spice Creek	WV-BST-109-L_01	Newson Branch	WVBST-78-H	5.76E+08		3.03E+07	6.06E+08
Spice Creek	WV-BST-109-M_01	Moorecamp Branch	WVBST-78-I	2.88E+08		1.52E+07	3.03E+08
Lower Hensley Creek	WV-BST-115_01	Lower Hensley Creek	WVBST-79	1.00E+09		5.26E+07	1.05E+09
Hensley Creek	WV-BST-116_01	Hensley Creek	WVBST-80	1.46E+09		7.66E+07	1.53E+09
Davy Branch	WV-BST-123_01	Davy Branch	WVBST-85	3.56E+09	7.58E+06	1.88E+08	3.75E+09
Davy Branch	WV-BST-123-A_01	Left Fork/Davy Branch	WVBST-85-A	1.15E+09		6.07E+07	1.21E+09
Davy Branch	WV-BST-123-G_01	UNT/Davy Branch RM 3.28	WVBST-85-G	2.73E+08		1.44E+07	2.88E+08

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Jenny Branch	WV-BST-125_01	Jenny Branch	WVBST-87	1.05E+09		5.54E+07	1.11E+09
Shannon Branch	WV-BST-132_01	Shannon Branch	WVBST-94	1.36E+09		7.17E+07	1.43E+09
Upper Shannon Branch	WV-BST-133_01	Upper Shannon Branch	WVBST-95	1.21E+09		6.38E+07	1.28E+09
Browns Creek	WV-BST-137_01	Browns Creek	WVBST-98	3.19E+09		1.68E+08	3.36E+09
Browns Creek	WV-BST-137_02	Browns Creek	WVBST-98	7.73E+09		4.07E+08	8.14E+09
Browns Creek	WV-BST-137-D_01	Puncheoncamp Branch	WVBST-98-A	3.27E+09		1.72E+08	3.44E+09
Browns Creek	WV-BST-137-H_01	Trail Fork	WVBST-98-B	1.31E+09		6.88E+07	1.38E+09
Elkhorn Creek	WV-BST-138_01	Elkhorn Creek	WVBST-99	7.46E+09	3.79E+06	3.93E+08	7.86E+09
Elkhorn Creek	WV-BST-138_03	Elkhorn Creek	WVBST-99	1.22E+10	3.79E+06	6.43E+08	1.29E+10
Elkhorn Creek	WV-BST-138_04	Elkhorn Creek	WVBST-99	3.81E+10	1.82E+08	2.01E+09	4.03E+10
Elkhorn Creek	WV-BST-138_05	Elkhorn Creek	WVBST-99	5.58E+10	3.61E+08	2.96E+09	5.92E+10
Elkhorn Creek	WV-BST-138-O_01	Laurel Branch	WVBST-99-E	3.84E+09		2.02E+08	4.04E+09
Elkhorn Creek	WV-BST-138-Q_01	Bottom Creek	WVBST-99-G	3.16E+09	4.70E+07	1.69E+08	3.38E+09
Elkhorn Creek	WV-BST-138-V_01	Coalbank Branch	WVBST-99-I	3.45E+09	5.68E+07	1.85E+08	3.69E+09
Elkhorn Creek	WV-BST-138-V-3_01	UNT/Coalbank Branch RM 0.82	WVBST-99-I-0.7	9.25E+08		4.87E+07	9.74E+08
Elkhorn Creek	WV-BST-138-V-5_01	UNT/Coalbank Branch RM 1.43	WVBST-99-I-2	4.37E+08		2.30E+07	4.60E+08
Elkhorn Creek	WV-BST-138-Z_01	North Fork/Elkhorn Creek	WVBST-99-L	4.53E+09	1.14E+08	2.44E+08	4.89E+09
Elkhorn Creek	WV-BST-138-Z_03	North Fork/Elkhorn Creek	WVBST-99-L	1.34E+10	1.14E+08	7.13E+08	1.43E+10
Elkhorn Creek	WV-BST-138-Z-3_01	Bearwallow Branch	WVBST-99-L-2	1.33E+09		6.99E+07	1.40E+09
Elkhorn Creek	WV-BST-138-Z-5_01	Greenbrier Hollow (Leftwich Branch)	WVBST-99-L-3	1.50E+09		7.92E+07	1.58E+09
Elkhorn Creek	WV-BST-138-Z-6_01	Windmill Gap Branch	WVBST-99-L-4	1.57E+09	1.14E+08	8.87E+07	1.77E+09
Elkhorn Creek	WV-BST-138-AJ_01	UNT/Elkhorn Creek RM 20.15	WVBST-99-O.7	5.00E+08		2.63E+07	5.26E+08
Little Indian Creek	WV-BST-139_01	Little Indian Creek	WVBST-100	1.66E+09		8.73E+07	1.75E+09
Mitchell Branch	WV-BST-146_01	Mitchell Branch	WVBST-105	9.35E+08		4.92E+07	9.84E+08
Sandlick Creek	WV-BST-152_02	Sandlick Creek	WVBST-109	8.36E+09		4.40E+08	8.80E+09

TMDL Watershed	AUID Stream Code	Stream Name	WV Code	Load Allocations (counts /day)	Wasteload Allocation (counts /day)	Margin of Safety (counts /day)	TMDL (counts /day)
Sandlick Creek	WV-BST-152-A_01	Right Fork/Sandlick Creek	WVBST-109-A	1.28E+09		6.75E+07	1.35E+09
Sandlick Creek	WV-BST-152-E_01	UNT/Sandlick Creek RM 3.00	WVBST-109-D	4.74E+08		2.50E+07	4.99E+08
Leslie Branch	WV-BST-157_01	Leslie Branch	WVBST-114	1.15E+09		6.06E+07	1.21E+09
South Fork/Tug Fork	WV-BST-163_01	South Fork/Tug Fork	WVBST-115	4.71E+09		2.48E+08	4.96E+09
South Fork/Tug Fork	WV-BST-163_03	South Fork/Tug Fork	WVBST-115	1.22E+10	3.79E+06	6.43E+08	1.29E+10
South Fork/Tug Fork	WV-BST-163-B_01	Tea Branch	WVBST-115-A	2.16E+08		1.14E+07	2.28E+08
South Fork/Tug Fork	WV-BST-163-F_01	Jump Branch	WVBST-115-D	5.21E+08		2.74E+07	5.48E+08
South Fork/Tug Fork	WV-BST-163-J_01	Laurel Branch	WVBST-115-F	1.10E+09		5.77E+07	1.15E+09
South Fork/Tug Fork	WV-BST-163-N_01	UNT/South Fork RM 5.85/Tug Fork	WVBST-115-J	1.75E+09		9.24E+07	1.85E+09
UNT/Tug Fork RM 148.42	WV-BST-164_01	UNT/Tug Fork RM 148.42	WVBST-115.2	2.93E+08		1.54E+07	3.08E+08
Loop Branch	WV-BST-168_01	Loop Branch	WVBST-117	8.76E+08		4.61E+07	9.22E+08
UNT/Tug Fork RM 152.09	WV-BST-172_01	UNT/Tug Fork RM 152.09	WVBST-118.7	4.27E+08		2.25E+07	4.50E+08
Little Creek	WV-BST-174_01	Little Creek	WVBST-120	5.12E+09	3.79E+06	2.70E+08	5.39E+09
Little Creek	WV-BST-174-B_01	Indian Grave Branch	WVBST-120-A	7.69E+08	3.79E+06	4.06E+07	8.13E+08
Little Creek	WV-BST-174-C_01	Puncheoncamp Branch	WVBST-120-B	7.88E+08		4.15E+07	8.29E+08
UNT/Tug Fork RM 154.02	WV-BST-176_01	UNT/Tug Fork RM 154.02	WVBST-120.3	2.15E+08		1.13E+07	2.27E+08
Millseat Branch	WV-BST-178_01	Millseat Branch	WVBST-121	1.23E+09		6.49E+07	1.30E+09
Ballard Harmon Branch	WV-BST-179_01	Ballard Harmon Branch	WVBST-122	1.43E+09		7.52E+07	1.50E+09
Sams Branch	WV-BST-181_01	Sams Branch	WVBST-123	8.16E+08		4.29E+07	8.58E+08

NA = not applicable; UNT = unnamed tributary; RM = river mile.

"Scientific notation" is a method of writing or displaying numbers in terms of a decimal number between 1 and 10 multiplied by a power of 10. The scientific notation of 10,492, for example, is 1.0492 $\times 10^4$ or 1.0492E+4.

11.0 FUTURE GROWTH

11.1 Iron, Aluminum, and pH

With the exception of allowances provided for CSGP registrations discussed below, this TMDL does not include specific future growth allocations. However, the absence of specific future growth allocations does not prohibit the permitting of new or expanded activities in the watersheds of streams for which metals TMDLs have been developed. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits must be "consistent with the assumptions and requirements of any available WLAs for the discharge...." In addition, the federal regulations generally prohibit issuance of a permit to a new discharger "if the discharge from its construction or operation will cause or contribute to the violation of water quality standards." A discharge permit for a new discharger could be issued under the following scenarios:

- A new facility could be permitted anywhere in the watershed, provided that effluent limitations are based on the achievement of water quality standards at end-of-pipe for the pollutants of concern in the TMDL.

- NPDES permitting rules mandate effluent limitations for metals to be prescribed in the total recoverable form. West Virginia water quality criteria for iron are in total recoverable form and may be directly implemented.
- Because aluminum water quality criteria are in dissolved form, a dissolved/total pollutant translator is needed to determine total aluminum effluent limitations. In aluminum impaired warmwater fisheries, a new facility could be permitted if total aluminum effluent limitations are based on the dissolved aluminum, acute, aquatic life protection criterion and dissolved/total aluminum translation equal to 1.0.

- The alternative precipitation provisions of 40 CFR 434 that suspend applicability of iron and TSS limitations cannot be applied to new discharges in iron TMDL watersheds.

- Remining (under an NPDES permit) could occur without a specific allocation to the new permittee, provided that the requirements of existing State remining regulations are met. Remining activities will not worsen water quality and in some instances may result in improved water quality in abandoned mining areas.

- Reclamation and release of existing permits could provide an opportunity for future growth provided that permit release is conditioned on achieving discharge quality better than the WLA prescribed by the TMDL.

- Most traditional, non-mining point source discharges are assigned technology-based TSS effluent limitations. The iron associated with such discharges would not cause or contribute to violations of iron water quality standards. For example, NPDES permits for sewage treatment and industrial manufacturing facilities contain monthly average TSS effluent limitations between 30 and 100 mg/L. New point sources may be permitted in the watersheds of iron impaired streams with the implementation of applicable technology based TSS requirements. If iron is identified as a pollutant of concern in a process wastewater discharge from a new, non-mining activity, then the discharge can be permitted if effluent limitations are based on the achievement of water quality standards at end-of-pipe.

- Lands associated with the Construction Stormwater and Multi-sector Stormwater General Permits are not significant or causative sources of dissolved aluminum, or pH impairments. New registrations may be permitted in the watersheds of impaired streams without specific wasteload allocations for those parameters.

- Subwatershed-specific future growth allowances have been provided for site registrations under the CSGP. The successful TMDL allocation provides subwatershed-specific disturbed areas that may be registered under the general permit at any point in time. The iron allocation spreadsheet also provides cumulative area allowances of disturbed area for the immediate subwatershed and all upstream contributing subwatersheds. Projects in excess of the acreage provided for the immediate subwatershed may also be registered under the general permit, provided that the total registered disturbed area in the immediate subwatershed and all upstream subwatersheds is less than the cumulative area provided. Furthermore, projects with disturbed area larger than allowances may be registered under the general permit under any of the following provisions:

    - A larger total project area can be registered if the construction activity is authorized in phases that adhere to the future growth area allowances.

    - All disturbed areas that will occur on non-background land uses can be registered without regard to the future growth allowances.

    - Registration may be conditioned by implementing controls beyond those afforded by the general permit, if it can be demonstrated that the additional controls will result in a lower unit area loading condition than the 100 mg/l TSS expectation for typical permit BMPs and that the improved performance is proportional to the increased area.

11.2 Fecal Coliform Bacteria

Specific fecal coliform bacteria future growth allocations are not prescribed. The absence of specific future growth allocations does not prohibit new development in the watersheds of streams for which fecal coliform bacteria TMDLs have been developed, or preclude the permitting of new sewage treatment facilities.

In many cases, the implementation of the TMDLs will consist of providing public sewer service to unsewered areas. The NPDES permitting procedures for sewage treatment facilities include technology-based fecal coliform effluent limitations that are more stringent than applicable water quality criteria. Therefore, a new sewage treatment facility may be permitted anywhere in the watershed, provided that the permit includes monthly geometric mean and maximum daily fecal coliform limitations of 200 counts/100 mL and 400 counts/100 mL, respectively. Furthermore, WVDEP will not authorize construction of combined collection systems nor permit overflows from newly constructed collection systems.

12.0 PUBLIC PARTICIPATION

12.1 Public Meetings

Two informational public meetings were held, one on May 15, 2018 at Mingo Central High School and one on May 17, 2018 at the McDowell County Library. The meetings occurred prior to pre-TMDL stream monitoring and pollutant source tracking and included a general TMDL overview and a presentation of planned monitoring and data gathering activities.

WVDEP representatives hosted a virtual meeting to present an overview of the TMDL development process and answered questions on January 11, 2023.

12.2 Public Notice and Public Comment Period

The availability of draft TMDLs was advertised via email, social media, and news release. The notice was shared directly with interested stakeholders. Interested parties were invited to submit comments during the public comment period, which will begin on December 15, 2022 and end on January 31, 2023. The electronic documents were also posted on the WVDEP's internet site at www.dep.wv.gov/tmdl. An ESRI StoryMap has been created to provide an overview of the TMDL at https://storymaps.arcgis.com/stories/4f0820b824254fb1a5ca172c6092a020

12.3 Responsiveness Summary

WVDEP received combined written comments on the Draft TMDLs for the Tug Fork River watershed. Comments were submitted by West Virginia Rivers Coalition, representing the West Virginia Highlands Conservancy, WV Council of Trout Unlimited, West Virginia Environmental Council, and one individual, Erin Gardner. Comments and comment summaries are in boldface and italic. Agency responses appear in plain text.

Multiple commenters expressed opposition to using the family level, WV Stream Condition Index (WVSCI) instead of the Genus Level Index of Most Probably Stream Status (GLIMPSS) to identify biological impairments, stating "many moderately impaired streams are declared to be meeting their Aquatic Life Use despite the more precise [GLIMPSS] ***data indicating impairment." Commenters offered the Tug Fork River mainstem as an example of when WVSCI scores are at or above the attainment threshold, while GLIMPSS scores indicate impairment. Commenters asserted that WVDEP's decision to develop the*** [Aquatic Life Use Assessment and Biological Stressor Identification Procedure] ***to guide assessment, opposed to finalizing a procedural rule, was to avoid EPA scrutiny.***

WVDEP appreciates the concerns expressed by commenters regarding the assessment of aquatic life. However, these comments are not applicable to the impairments addressed in this project. WVDEP maintains that implementation of certain pollutant TMDLs will resolve biological impairment in waters listed in Table 4-1 of the TMDL document. All other biological impairments for which stressor identification was performed in the course of this TMDL development are presented in Appendix K.

Comments are relevant to the 303(d) List. USEPA will have an opportunity to consider assessment methodologies and listing decisions during their review of the draft 2018/2020/2022 WV Integrated Water Quality Monitoring Report, including the 303(d) List.

Commenters expressed frustration at what is perceived as WVDEP shirking their responsibility to address biologically impaired streams for which ionic stress was identified as a stressor in the draft Tug Fork River TMDL. Commenters point to the efficiencies of developing holistic watershed wide TMDLs that address all known impairments at the same time. Commenters cite language from the Coal River Watershed TMDL Report dated September 2006 deferring biological TMDLs to resolve impairment of aquatic life due to stress from ionic toxicity.

Since 2017, WVDEP has been cooperating with the USEPA to develop a TMDL endpoint and watershed model to address biological stress resulting from ionic strength. WVDEP has contributed by identifying a project area and impaired streams, conducting pollutant source tracking, providing water quality data for endpoint analysis and model setup, and participating in workgroups.

WVDEP maintains that addressing impairments through a holistic watershed wide TMDL does provide efficiency. This is particularly true in the pre-TMDL monitoring and model stages of TMDL development. For this reason, WVDEP has made a concerted effort to collect necessary data to inform stressor identification, as well as TMDL development in the future. One goal for ionic strength model selection was to make use of modeling framework established in WVDEP TMDL projects, (e.g., landuse, point discharges, hydrologic parameters, etc). These data and resources will be transferrable to future TMDLs to address ionic strength.

Commenters assert that WVDEP should assess selenium water column data independent of fish tissue in streams impacted by active mining. Commenters claim that delaying TMDL development to confirm impairment through fish tissue is not justified and water column data is clearly more reflective of the water quality, opposed to fish tissue.

WVDEP has assessed water column data for streams in the Tug Fork River watershed and listed impairments based on water column in the West Virginia 2018/2020/2022 303(d) List for impaired waters.

Federal and state water quality standards for aquatic life selenium criteria are structured the same, in which fish tissue and particularly egg/ovary tissue are seen as better measures of water quality attainment, given the bioaccumulative nature of selenium. When seeking guidance on applying the selenium criteria, WVDEP found that in an October 2021 draft guidance document (EPA 823-D-21-004) from the Office of Water, the USEPA recommends that states collect fish tissue data to support assessment of the recommended selenium criterion. USEPA guidance goes on to say, "*After a waterbody is added to a CWA section 303(d) list based on water column data alone, states and authorized tribes may consider collecting fish tissue data to confirm the assessment determination before developing a water quality management plan (e.g., TMDL).*"

Including fish tissue in the assessment and TMDL development process will allow the WVDEP to appropriately assign wasteload allocations that are protective of the selenium water quality standard. In the meantime, WVDEP will continue to control selenium discharges through the NPDES permitting program, taking into account the selenium impairment listing in the 303(d) List.

One commenter specifically expressed concerns about the negative impacts to the federally threatened Big Sandy crayfish, because of bioaccumulation of selenium in aquatic food chains and impacts to reproduction.

WVDEP agrees and appreciates this comment. State and federal selenium water quality criteria for fish tissue are developed to be protective of all aquatic life, and each undergo an evaluation specifically pertaining to threatened and endangered species. As such, nonattainment of the existing selenium water quality criteria for fish tissue is of concern with respect to efforts to protect the threatened Big Sandy crayfish. WVDEP has applied the selenium water quality criteria to list impairment on the draft 2018/2020/2022 303(d) list, as well as previous approved lists.

Commenters contended that existing point sources of fecal coliform are underrepresented in the calibration model citing notice of violations issued to permitted facilities. Commenters assert that a 10% MOS should be considered for the fecal coliform TMDL.

WVDEP recognizes the concern raised but permit non-compliance would not be resolved by increased TMDL margins of safety. The role of the TMDL is to prescribe wasteload allocations and load allocations that result in water quality criteria attainment and the margin of safety component is intended to account for uncertainty. With respect to wasteload allocations for point sources in fecal coliform TMDLs, there is virtual certainty that those sources would not cause or contribute to criteria nonattainment if the wasteload allocations are properly implemented. The implementation expectation is to convert the wasteload allocations to NPDES effluent limitations per the recommendations of EPA's Technical Support Document for Water Quality Based Toxics Control. When the wasteload allocations are implemented in NPDES permits and effluent limitations are complied with, the resulting effluent quality is better than that required instream by the criteria. A 10% margin of safety would not result in a lower wasteload allocation for permitted source of fecal coliform. As such, an increased margin of safety to address permit non-compliance is not justifiable.

NPDES Permit non-compliance is a significant issue to be addressed through the Environmental Enforcement section of the DWWM and is outside the purview of this TMDL.

Commenters asserted that more water quality data from Virginia and Kentucky and enhanced coordination between states will be needed to ensure the Tug Fork mainstem meets the TMDL endpoint.

To the extent possible, WVDEP coordinated the pre-TMDL monitoring and Tug Fork River TMDL development schedule with the Commonwealths of Virginia and Kentucky, as well as USEPA Regions 3 and 4. Preparing the Tug Fork River TMDL was a priority for WVDEP. When it became clear that Kentucky would be unable to provide data for the development of the

TMDL, USEPA assumed responsibility for gathering data to inform the TMDL model. With the exception of a few small tributaries, any drainage from Virginia to the Tug Fork River is indirect through monitored tributaries in West Virginia and Kentucky. WVDEP is unable to monitor every named and coded stream in a TMDL watershed, and instead relies on the watershed model to predict water quality for unmonitored streams. Selecting seven of the major Kentucky tributaries to monitor is in keeping with that practice and purpose of the model. Even so, the TMDL makes it clear that the presentation of the relative load from Kentucky is based on a coarser level landuse representation. Reductions prescribed to the loads from Kentucky and Virginia streams result in attainment of WV water quality standards in West Virginia waters, specifically at modeling assessment points on the Tug Fork River mainstem. If in the future the opportunity arises, WVDEP will contribute to efforts from Kentucky or Virginia to further divide the generalized load allocations provided for their portions of the watershed in the Tug Fork TMDL.

Commenters recommended that WVDEP Watershed Assessment Branch enhance coordination and cooperation with other Divisions and Office in the agency during TMDL development and implementation. Commenters provided specific scenarios in which the Watershed Assessment Branch could coordinate, including consideration of compliance issue, identification of Abandoned Mine Land (AML) sources, and in regard to potentially failing septic systems. Commenters describe how WLA are incorporated into new or reissued permits and ask that similar efforts be made to share information with those whose work is related to non-point sources. One commenter expressed support for the development and implementation of fecal coliform TMDLs.

The WVDEP Watershed Assessment Branch dedicates significant resources toward pollutant source tracking efforts through field surveys, desktop reviews of GIS and permit information, and collaboration with intra-agency and interagency partners, to properly characterize pollutants in TMDL models. As to the specific scenarios mentioned, staff currently share detection of non-compliance with inspectors to be addressed, utilize all available AML data and perform field investigations to address data gaps, and survey unsewered areas to ascertain how best to represent areas where septic systems may be a significant source of fecal coliform pollution. The Watershed Assessment Branch will continue to seek out opportunities to incorporate and/or refine data sources in the modeling approach.

As a point of clarification, implementation of TMDL WLA in reissued permits is required through federal law (40 CFR §122.44 (d)(1)(vii)(B)). Implementation of load allocation is achieved through voluntary participation and supported through federal funding authorized by the Clean Water Act Section 319. The Division of Water and Waste Management Watershed Improvement Branch oversees the Section 319 funding program for the WVDEP.

Staff from the Watershed Assessment Branch regularly respond to requests from the Watershed Improvement Branch to support efforts of watershed associations by providing training to citizen scientists, interpretation of TMDLs, resources for writing watershed-based plans, and additional water quality monitoring. Staff of the Watershed Assessment Branch will continue to seek out opportunities to contribute to the implementation of the TMDLs.

13.0 REASONABLE ASSURANCE

Reasonable assurance for maintenance and improvement of water quality in the affected watershed rests primarily with two programs. The NPDES permitting program is implemented by WVDEP to control point source discharges. WVDEP's Watershed Improvement Branch (WIB) mission is to inspire and empower people to value and work for clean water. WIB administers programs that educate, provide assistance, plan and implement water quality protection, improvement and restoration projects.

13.1 NPDES Permitting

WVDEP's Division of Water and Waste Management (DWWM) is responsible for issuing non-mining NPDES permits within the State. WVDEP's Division of Mining and Reclamation (DMR) develops NPDES permits for mining activities. As part of the permit review process, permit writers have the responsibility to incorporate the required TMDL WLAs into new or reissued permits. New facilities will be permitted in accordance with future growth provisions described in **Section 11**.

Both the permitting and TMDL development processes have been synchronized with the Watershed Management Framework cycle, intending that the TMDLs are completed just before the permit expiration/reissuance time frames. In order to address priorities on the 303d list, WVDEP deviated from the framework for this TMDL project in Group C for the Tug Fork River watershed. Because this TMDL was developed ahead of the scheduled sequence, implementation of this TMDL will be accomplished in the next reissuance.

While there are no existing MS4s in the Tug Fork Watershed, the MS4 permitting program could be implemented in the future to address stormwater impacts from urbanized areas. West Virginia has developed a General NPDES Permit for MS4 discharges (WV0110625). All of the cities with MS4 permits in subject waters of this report, plus the West Virginia Department of Transportation (WVDOH) are registered under the permit. The permit is based upon national guidance and is non-traditional in that it does not contain numeric effluent limitations, but instead proposes Best Management Practices that must be implemented. At permit reissuance, registrants will be expected to specifically describe management practices intended for implementation that will achieve the WLAs prescribed in applicable TMDLs. A mechanism to assess the effectiveness of the BMPs in achieving the WLAs must also be provided. The TMDLs are not intended to mandate imposition of numerical effluent limitations and/or discharge monitoring requirements for MS4s. Reasonable alternative methodologies may be employed for targeting and assessing BMP effectiveness in relation to prescribed WLAs. The "MS4 WLA Detailed" tabs on the allocation spreadsheets WLAs provide drainage areas of various land use types represented in the baseline condition (without BMPs) for each MS4 entity at the subwatershed scale. Through consideration of anticipated removal efficiencies of selected BMPs and their areas of application, it is anticipated that this information will allow MS4 permittees to make meaningful predictions of performance under the permit.

DWWM also implements a program to control discharges from CSOs. Specified fecal coliform WLAs for CSOs will be implemented in accordance with the provisions of the national

Combined Sewer Overflow Control Policy and the state Combined Sewer Overflow Strategy. Those programs recognize that comprehensive CSO control may require significant resources and an extended period of time to accomplish. The WLAs prescribed for CSOs are necessary to achieve current fecal coliform water quality criteria. However, the TMDL should not be construed to supersede the prioritization and scheduling of CSO controls and actions pursuant to the national CSO program. Nor are the TMDLs intended to prohibit the pursuit of the water quality standard revisions envisioned in the national policy. TMDLs may be modified to properly implement future water quality standard revisions (designated use and/or criteria), if enacted and approved by the USEPA.

13.2 Watershed Improvement Branch – Nonpoint Source Program

The mission of the WVDEP Watershed Improvement Branch Nonpoint Source (NPS) Program is to inspire and empower people to value and work for clean water. The NPS Program coordinates efforts by multi-agency and non-governmental organizations to address nonpoint sources of pollution. In relationship to implementation of TMDLs, one key role that the NPS Program plays is administering the Clean Water Act Section 319 grant funding program. These funds are available to restore impaired waters through the development of watershed based plans, execution of watershed projects, and support to watershed organizations and other nonpoint partners. To learn more about the NPS Program visit:

https://dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx

Additional information regarding support specifically in the Tug Fork River Watershed, contact the Watershed Improvement Branch Southern Basin Coordinator Jennifer Liddle.

There is an active citizen-based watershed association representing the Tug Fork River watershed, Friends of the Tug Fork. For additional information concerning associations, visit: https://dep.wv.gov/WWE/getinvolved/WSA_Support/Pages/WGs.aspx

13.3 Public Sewer Projects

Within WVDEP DWWM, the Engineering and Permitting Branch’s Engineering Section is charged with the responsibility of evaluating sewer projects and providing funding, where available, for those projects. All municipal wastewater loans issued through the State Revolving Fund (SRF) program are subject to a detailed engineering review of the engineering report, design report, construction plans, specifications, and bidding documents. The staff performs periodic on-site inspections during construction to ascertain the progress of the project and compliance with the plans and specifications. Where the community does not use SRF funds to undertake a project, the staff still performs engineering reviews for the agency on all POTWs prior to permit issuance or modification. For further information on upcoming projects, a list of funded and pending water and wastewater projects in West Virginia can be found at http://www.wvinfrastructure.com/projects/index.php.

14.0 MONITORING PLAN

The following monitoring activities are recommended:

14.1 NPDES Compliance

WVDEP's DWWM and DMR have the responsibility to ensure that NPDES permits contain effluent limitations as prescribed by the TMDL WLAs and to assess and compel compliance. The length of time afforded to achieve compliance may vary by discharge type or other factors and is a case-by-case determination in the permitting process. Permits will contain self-monitoring and reporting requirements that are periodically reviewed by WVDEP. WVDEP also inspects treatment facilities and independently monitors NPDES discharges. The combination of these efforts will ensure implementation of the TMDL WLAs.

14.2 Nonpoint Source Project Monitoring

All nonpoint source restoration projects should include a monitoring component specifically designed to document resultant local improvements in water quality. These data may also be used to predict expected pollutant reductions from similar future projects.

14.3 TMDL Effectiveness Monitoring

TMDL effectiveness monitoring should be performed to document water quality improvements after significant implementation activity has occurred where little change in water quality would otherwise be expected. Full TMDL implementation will take significant time and resources, particularly with respect to the abatement of nonpoint source impacts. WVDEP will continue monitoring on the rotating basin cycle and will include a specific TMDL effectiveness component in waters where significant TMDL implementation has occurred.

15.0 REFERENCES

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